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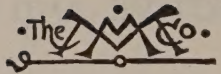

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LOGIC

DEDUCTIVE AND INDUCTIVE

BY

THOMAS CRUMLEY, C.S.C.

Professor of Logic in the University of Notre Dame

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PREFACE

THIS text has been prepared for those who are newly entering upon the study of Logic. It comprises therefore no more than the elements of the subject. It differs from similar manuals, as these generally differ from one another, not so much in the choice as in the presentation of topics. Tradition has rather strictly determined the matter to be considered in Formal Logic at least, but a good deal of freedom is shown with regard to the manner of treatment.

For one thing individual opinion dictates the degree of thoroughness with which explanations shall be made. In the present instance it was intended that the essentials of the subject be neither hidden by too much detail nor displayed as a forbidding skeleton. Occasional discussions have been admitted on the ground that truth often becomes clearer and more striking when it is set over against error.

For another thing a treatise on Logic cannot fail to reflect the writer's attitude towards philosophy in general. His views of metaphysics, psychology, and epistemology must necessarily come to light, yet not infrequently his opinions about ethics and natural theology obtrude themselves. Even elementary textbooks are full of idealism and empiricism when they are not replete with realism. Accordingly it is desirable that the beginner be introduced to doctrines which are consistent with the highest tenets of moral-

ity and religion. From many sides there has come the cry, "Back to Aristotle!" Fortunately Scholasticism never wandered far from the teachings of its great master, and those who follow this system—as we do here—are free from the strain, not to say the uncertainty, that always accompanies a retracing of steps.

How much of what is reproduced in an elementary text has been assimilated from promiscuous reading and how much is more directly attributable to particular authors cannot easily be determined; nevertheless the writer gratefully acknowledges the invaluable aid he has received from the following books: *"Institutiones Logicales,"* by T. Pesch, S.J.; *The Science of Logic,* by P. Coffey; *Principles of Logic,* by G. H. Joyce, S.J.; *A Manual of Logic,* by J. Welton; and *An Introduction to Logic,* by H. Joseph.

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PART I

DEDUCTION

Logic: Deductive and Inductive

CHAPTER I

THE NATURE AND SCOPE OF LOGIC

It is doubtless true that the entire reach and full significance of an exact definition of a science cannot be grasped except by the advanced student, and yet there seems to be an advantage in offering such a definition even to the beginner. First impressions are usually lasting, and should the initial explanation of the scope of a subject be vague, the vagueness is apt to persist. An exact definition is at least a fixed object of thought; it may confidently be held in mind as a formula which will become more and more serviceable. Unlike a description that covers the ground provisionally it will not have to be set aside later on for something better. It can be employed again and again without alteration and with a fair prospect of growing in meaning. Accordingly, as an introduction to our study we suggest the following

DEFINITION OF LOGIC

Logic is the science of the laws that guide us in reasoning to truth. A consideration of the terms of this formula may throw light on the nature and scope of the subject.

1. *Logic a Science rather than an Art.* Whether Logic is a science or an art may be regarded as a question of secondary importance, yet to dismiss it without some discussion might leave room for criticism.

Logic has been called an art only, a science only, and also an art as well as a science. That it is a science only would seem to be the most consistent of these views.

One reason for assuming Logic to be an art lies in the fact that the laws of thought seem to be so directly studied with a view of applying them. It should be remembered, however, that since the cognitive side of our nature is intended to serve the conative side, no knowledge is accumulated merely for its own sake. What we learn we put to use; sooner or later the demands of living tap the sources of even the purest theorizing. The simple relation of knowledge to utility, therefore, is hardly a sufficient ground for a complete distinction between science and art.

The familiar statement that science teaches us to know while art teaches us to do is not altogether satisfactory. There are principles in art, otherwise its processes could not be directed, its effects could not be intended; and although science at times appears to rest in the quiet contemplation of truth, there are other times when its investigations are focused on the solution of practical problems. Hence, as the term art would lose significance were it used to cover all that is practical in science, similarly the term science would miss a valuable content were it used to cover all that is critical in art. Logic, then, should be shown to have a stricter right to be classed as an art than is implied by the close bearing of its rules on actual thinking.

Art teaches us to do but so does science; they differ in respect of the purpose of their teaching. Science teaches us to make substitutions for nature; art teaches us to interpret nature, to render an account in marble,

in design, in words, in sound, in color, of the changes wrought in our soul by the persons and things around us. The physical sciences help us to reproduce at will *substances,* such as foods, clothing, material for houses, and *phenomena,* such as light, heat, power for transportation. The mental sciences help us to reproduce at will conscious processes that occur naturally, though in a sense accidentally, such as valid acts of reasoning or morally good acts of the will. Science whether physical or mental aims to discover how nature works and then teaches us to work in like manner. It therefore repeats nature, or as we have said substitutes for it. Art on the other hand teaches us to reveal our impressions of nature. We are played upon by the forces of the universe. What is our response to them—what striking turns of thought, what intensity of feeling do they awaken? Art helps to answer the question by showing us how to put ourselves into our work. For above all else art involves personal expression. The things that give rise to the annoying "personal equation" in science make for distinction and style in art; the shape of a painter's hand, the structure of a musician's ear, the anatomy of a sculptor's arm, the tone of a poet's nerves, will stand out in his work and perhaps lend a precious charm. The rules of art then provide for a large freedom in carrying a work to a successful end; whereas the laws of science aiming at absolute sameness of results take no account of individual peculiarities.

And obviously no personal element, no peculiar manner, no individual style, can enter into the business of attaining truth through reasoning. The embellishment of truth, its employment for the purpose of persuading people, of uplifting them, of

inciting them to action—these are problems with which the art of rhetoric is concerned. The object of logical study is to discover the means that will enable us to reproduce, with definite knowledge of the steps to take, processes which may and at times do occur, as we say, naturally. To call such a study by the name of "art" or "art criticism" might be misleading.

We may therefore regard the investigations that Logic pursues as *theoretical science* and the practical employment of them in particular cases as *applied science.*

2. LAW. There are three general meanings of the word "law."

A. Primarily it signifies the command of one who has the right to control the conduct of men. Consequently law in this sense amounts to a principle of action, a source of behavior; and the result of obedience to law is a marked uniformity in the ways and manners of a community.

B. Now this uniformity has a striking analogy in the regularity that prevails among natural phenomena. The invariability with which physical effects occur suggests an origin as single and compelling as the will of a legislator. Accordingly when this origin, principle, source, or cause is discovered it is called a law. This use of the word, however, does not carry the idea of a governing power. The laws of nature are simply generalized expressions of facts; at most they reveal the conditions that are essential to the production of a given effect.

C. From an objective point of view the will of a legislator may be regarded as the cause of specific social changes. On the other hand a subject endowed with free will may look upon the superior's com-

mand as a private means of attaining a chosen end; and thus law comes to signify a guiding principle, a course which must be followed in order to reach a determined goal.

It is in this third signification that the word "law" is employed in art and in the so-called normative sciences—those, namely, that seek to establish a standard according to which human action may attain to order and perfection. For instance, Ethics is a normative science because it studies the principles by which men may direct their conduct; Aesthetics is normative because it investigates the sources that lead to the attainment of the beautiful; and inasmuch as Logic aims to furnish men with standards of correct thinking it too may be classed as a normative science. Of course morality, beauty and truth may be attained without much knowledge of how or why a particular step is taken, yet if one aims to make each step a reasoned means to an end one must follow the guide of law. Hence although Logic does indeed discover for us the grounds on which reasoning previously accomplished is valid, it may more profitably be regarded as looking towards the future, as serving to set forth the conditions that must be met before the mind can confidently get new judgments out of what it already knows.

3. REASONING. It should not be thought that reasoning is the only means by which truth can be acquired. As a matter of fact, experience in a large sense, comprising what we are told on acceptable authority as well as what we see and feel for ourselves, is the chief source of knowledge. Coming into contact with objects is clearly the surest way of learning their characteristics. That the sun shines,

for instance, needs no proof; it is evident through sense perception. Indeed it cannot be proved, for in the very nature of the case there is no basis for a process of reasoning. Judgments that do not require to be supported by argument are not of course restricted to sense experience. For instance, that "the whole is greater than any of its parts" carries immediate conviction once there is an understanding of the terms involved. Now with truth acquired directly by means of either sensory or intellectual intuition, Logic has nothing specifically to do. It is concerned with judgments that need proof, that could not be known unless something else were previously known. For example, that "All who deserve the fair are brave" might not, considered alone, be an acceptable proposition, yet it is involved in the proposition "None but the brave deserves the fair." One who grants the second must accept the first, though some effort may be required to pass from the second to the first. The passing itself is an act of inference or reasoning—the ultimate logical process. A problem for Logic arises only when a truth lies somehow hidden in what is already known. To reveal truth so concealed, to disclose it as something new and fresh, is the function of reasoning. Reasoning is thus an expanding of knowledge, a pressing forward from established propositions to whatever may be implied in them.

4. TRUTH. Logical truth is the conformity of the intellect with reality. "Conformity" in this definition means the act of establishing a conceptual relation which has its counterpart in things; for it is usually held that without this act, the act of judgment, there is no truth. Every mind of course is equipped with a great many ideas which may be used

to interpret reality, yet until they are so used they are not said to be either true or false. "Hardness," for instance, is an idea that is well understood, but in itself it is merely a meaning capable of explaining in part the nature of certain substances. It may, for example, be compared with "iron" or with "water" or with "man;" and in each case there may result an affirmative truth, for iron, some water, and some men are hard. But plainly, as this example shows, "hardness," apart from its association with other ideas, is no more than a potential element of truth. Accordingly it is only when a concept is affirmed or denied of another concept that there is truth, for only then is there any conformity of the intellect with reality. Truth therefore is properly regarded as residing in judgments.

But if judgments are intellectual acts which affirm or deny one concept or another, how, it may be asked, can truth have to do with *things?* Would it not rather pertain to conceptual relations alone, and would it not therefore amount to consistency between ideas? Truth would indeed be a personal and consequently a trivial matter were it the result of matching mere ideas that have no objective reference. The solution of this difficulty is found in the doctrine that, since there are no innate ideas, the very existence of concepts can be accounted for only by regarding them as products that have been built up out of extramental material which is first known through the senses. Moreover the validity of every step in the formation of concepts can be guaranteed only by repeated references to reality. The test of truth is the exactness with which a judgment corresponds to things as they are. It is impossible to detect error

except by pointing out a discrepancy between a belief announced and the object which is claimed to be known; but there is ultimately the same ground of certitude for insistence upon truth as there is for detection of error. In both cases there is something outside the judgment to which an appeal for verification can be made.

The phrase "reasoning to truth" has an important place in our definition. The word "reasoning" alone would not have sufficed because it is possible by means of inference to establish erroneous propositions. Were Logic a purely formal science, its laws could be applied without considering concepts as equivalent to things. Since, however, concepts form no part of truth until they are used with specific reference to objects, it follows that without the proper interpretation of a concept as used in a given judgment, logical processes far from leading to truth will seem to be altogether meaningless. Accordingly the logician's responsibility does not cease at the point where reasoning is formally valid; on the contrary it reaches to the uttermost confines of truth, including at least indirectly the question of whether judgments conform to things as they are, and directly to the question of whether propositions accurately convey thought. In view of this conception of the scope of Logic, it must be regarded as an applied as well as a theoretical science.

II. THE SUBJECT MATTER OF LOGIC

Our definition sufficiently indicates that the general subject matter of Logic is the nature and regulative principles of reasoning. But since reasoning is based on judgment and judgment on conception, a treat-

ment of these more fundamental processes will be necessary. Moreover, all these acts of the intellect are intimately bound up with the language forms which express them, and consequently these forms themselves are proper subjects for consideration. A brief explanation of the foregoing statements may be helpful.

1. As we have seen, the function of reasoning is to uncover truth where truth lies hidden. But implied as well as expressed truth resides in judgments, and the unfolding of the former (a truth implied) is always set forth in a judgment. For instance, seeing that A is greater than B at the same time that B is greater than C, one may infer the truth that A is greater than C. If however A, B, and C had never been compared, if in other words they were known merely apart, or out of relation, no new truth could be acquired. Reasoning can not begin therefore until concepts are compared, and since the validity of reasoning depends upon the precise way in which relations are presented, a study of the act of judgment in all its phases should form a part of the discipline of Logic.

2. Judgment itself, however, presupposes the existence of concepts, and the very essence of an announced relation grows out of the nature of the concepts compared. This means that whether we shall affirm or deny in a particular case depends upon what we are thinking of as predicate and as subject. For example, if "blessed" were a contemplated predicate and "the poor" a possible subject, the mind would hesitate to conjoin the two until either the application of the subject were limited to "some of the poor" or—what might be better—its implica-

tion restricted to "the poor in spirit." Thus it is of first importance to study the nature of concepts and the various ways in which they may be employed to reveal the world around us.

On the basis, therefore, of the mental processes engaged in acquiring new truth from what is already known, a division of Logic would include conception, judging, and reasoning.

3. LOGIC AND LANGUAGE. Language has two functions; it not only (a) conveys thought but also (b) helps us to think. From the point of view of both these functions language can be shown to have a close bearing on Logic.

a. Language in the broadest sense is the only means by which thought can be transmitted from one mind to another. Accordingly the mental processes with which Logic deals could receive no general attention unless they were conveyed into the external world through certain language forms. It is necessary of course to know what these forms are and to understand how and how far they symbolize thought. Hence Logic considers Terms, Propositions and Syllogisms as the expressions respectively of concepts, judgments and acts of reasoning.

Now if a term always had the same meaning and if words in a given arrangement could admit of only one interpretation, the logician's treatment of language might be purely formal and yet be entirely adequate. It is a recognized fact, however, that language is an imperfect vehicle for thought transmission. On the part of him who hears or reads there is danger of unintentional misconstruction and on the part of him who speaks or writes there may be a deliberate and successful attempt to mislead. And

surely it would be the concern of no one more than the logician to point out the ambiguities, the loose statements of truth, and the errors of reasoning that are directly due to the inadequacy of language as a means of conveying thought. Hence the subject matter of Logic includes Material Fallacies—the false processes of inference that arise from the equivocation of terms and from unwarranted assumptions concealed perhaps in a setting of plausible phrases.

b. Language is also an instrument for thinking. In fact, thought and language are so intimately connected that the one seldom exists without the other. No doubt we have frequent flashes of pure thought which throw a momentary light on phases of reality, but ordinarily the various acts of thinking—forming concepts, judging, reasoning—can not be extensively and effectively pursued without the aid of language. This is so because language is constructed out of word-images that are associated with concepts; and if it is true that the concept often reinstates the appropriate word-image it is also true that the word-image often calls for the concept. Carelessness in forming associations of this sort would inevitably lead to slovenly thinking. Again, the name in the mind seems frequently to do the work of a concept; for in the stress and haste of getting on from one step of a process to another there is not always time to formulate a meaning. Language in this respect is the shorthand of thought, and as such has value only to the extent that it is accurate. For purposes of our own thinking, therefore, no effort should be spared to acquire a copious stock of well-discriminated words. Each shade and degree of meaning has an appropriate term, a knowledge of which will help us to reason

clearly and correctly. To seek the appropriate term and to use it frequently in connection with the idea it stands for is a practice every student of Logic should cultivate.

III. GENERAL METHODS OF LOGIC

The arrangement of processes in a series with reference to a definite end is called Method. In general, thought processes take one of two directions: they "descend" from principles to particular truths; or, beginning with observation, they "ascend" to laws that explain the facts of sense experience. The first of these methods is known as Deduction, the second as Induction.

DEDUCTION AND INDUCTION. Induction is commonly regarded as the "inverse" of deduction, and because the term "deduction" can be applied not only to a method but also to processes of inference, it is assumed that there are processes of inference of an opposite sort to which the name of induction may be given. This, however, is not true. Inference is always progressive; it means simply an advance in thought from a truth already known to what is implied in that truth: consequently all inference is deductive inasmuch as it signifies that the limited truth we conclude to is contained in the larger truth we start from. An inverse process of inference—a passing from the unknown to the known—could not be conceived. There is no such thing, then, as inductive inference.

There is, however, an inductive method—an ordered scheme of mental activities by which from a consideration of concrete cases we may rise to the discovery and proof of general laws. It is customary

at present to treat this method, especially in its application to the natural sciences, as a separate part of Logic. The plan may be profitably adopted in order to emphasize the fact that since induction is merely a method, a study of it should not be confused with deduction, which is not only the name of a method but which can stand as the title to a discussion of Logic proper.

We may accordingly divide our study of Logic into two parts, Deduction and Induction. The first part will include the topics set down in the preceding section under the heading of Subject Matter—I. Concepts and Terms, II. Judgments and Propositions, III. Reasoning and the Syllogism, IV. Material Fallacies. The second part will take up the nature of Induction, its various steps, the principles on which it rests—Causality and the Uniformity of Nature—and the so-called Scientific Methods.

QUESTIONS

1. Does the fact that Logic has a practical as well as a theoretical aspect justify us in calling it both a science and an art?
2. What is meant by saying that "the cognitive side of our nature is intended to serve the conative side"? Illustrate the statement by examples from your own experience.
3. Name some principles governing composition in painting, music, architecture, rhetoric.
4. Show that the purpose of science differs from that of art.
5. Is it the aim of Logic to develop what may be personal in our manner of thinking?
6. Explain the three meanings of the word "law." In what sense is it used in our definition?
7. What is a normative science? Why should Logic be regarded as normative?
8. In what way does "reasoning" (used in our definition as synonymous with "inferring") differ from other ways of acquiring knowledge?

9. Show by means of an example what is characteristic of every logical problem.

10. Define Logical truth.

11. Give a reason for saying that truth does not lie in concepts considered out of relation.

12. What ground is there for the statement that the ultimate test of truth is objective?

13. Why are terms included in the subject matter of Logic?

14. On what condition might Logic be studied in a purely formal or symbolic way?

15. Give two reasons for regarding language not merely as a medium of expression but as an instrument for thinking.

16. Why are all processes of inference deductive?

17. What briefly is the difference between the Deductive and Inductive Methods?

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CHAPTER II

CONCEPTS AND PERCEPTS

CONCEPTS AS PRODUCTS OF PROCESSES. The words "concept" and "percept" are sometimes employed with a misleading reference. While of course they are rightly used to denote the products of their respective processes, it should be remembered that these products are not static things, for they have no place in the mind when the processes cease. The only existence they have is during the course of the processes. "Concept," for example, is generally understood in the same way as the noun "throw" in the sentence "He made a good throw." Language as well as thought in this case has transformed what was really an action into a fictitious substantive element; for all that could be literally expressed by the word "throw" is what actually took place, that is, sending the ball through the air. In like manner the concept may be regarded as the conception completed, but only on the understanding that it does not remain a product in the mind after the process of conception ceases. We do, indeed, say that we hold the concept in consciousness for awhile, yet such holding is itself a mental activity. If it is asked, Where are concepts after the processes that have formed them cease? the answer is they are nowhere except in the capacity of the mind to form them again.

CONCEPT AND PERCEPT. Since "concept" and "percept" are to be understood with a dynamic rather than a static reference, they may perhaps be distinguished more satisfactorily by showing the difference between their corresponding processes. But before taking up this distinction we should observe that what can be said of percepts is true also of images, the products of memory and imagination.

Conception is an act by which the mind reaches out to all things that possess the same nature. Sense perception, on the contrary, reaches out to only this or that individual. Through sense perception the mind comes in contact with qualities no one of which has apparently any more importance than the others in the make-up of the object. On the other hand, through conception the mind comes in contact with qualities which it has singled out as constituting the essence common to a multitude of objects. The important point to notice is that in conception, attention is given to general characteristics. In so far as interest is focused on individual characteristics merely there is never anything more than sense knowledge. There are certain qualities without which a particular thing cannot exist—animality and rationality, for example, in the case of man; and the discovery of these qualities—often a difficult task requiring many judgments and even arguments—is called *forming the concept*, the discovered qualities themselves constituting the *content of the concept*.

The senses of course furnish the material out of which the concept is formed; for it is only through them that we can lay hold on the world outside. As things exist concretely they are individual, possessing all their attributes in their own right, and they

find entrance into the mind bearing whatever they possess with them. The content of a percept, therefore, is the sum of the qualities which taken together compose the single object. What qualities may be proper and what common, sense knowledge cannot reveal: this is the problem of the intellect by which alone the universe with its orders and classes can be understood. If, however, there are orders and classes it is only because each of the individuals that compose them possesses a set of characteristics common to the order or class. These characteristics, regarded as necessarily belonging to each individual, are said to constitute an essence or a nature; they are merely a part of the concrete thing, yet they form the part that the intellect needs in order to construct its edifice of truth. Inasmuch as sense-qualities show no sign of being either essential to a nature or simply proper to an individual the first work of the intellect is to examine every item of perceptual experience with a view of ascertaining whether it is a class-attribute or not. Such examination, equivalent to an analysis of the concrete objects of sense-knowledge, is called abstraction. Practically, then, in abstraction, the intellect evaluates *all* the qualities; it recognizes individuating marks as such, but in the pursuit of its purpose puts them aside (abstracts or withdraws attention from them) and centers its interest on the common qualities.

THE "SENSUOUS" AND THE INTELLECTUAL UNIVERSAL. The relation between the percept and the concept might become clearer through a study of the percept before and after the dawn of reasoning. The child has percepts before it can exercise its intellectual power. Also, there is no doubt it appreciates the

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sameness of certain objects. After a little experience, for example, it can recognize a horse whenever it sees one. But if it detects differences between horses, it also notes likenesses between them. The child's experience can hardly be described in any other way, yet this description of the facts—emphasizing the discernment of likeness and unlikeness—would seem to fit intellectual activity quite as well. The detection of sameness, however, either in repeated presentations of one individual or in several presentations of different individuals, hardly implies anything more than the power of recognition. Perhaps it may be granted that at the bottom of the child's ability to form an image of a horse on hearing the appropriate word there is a kind of abstraction, but it is sensory and not intellectual abstraction, and its product is what has been called a "sensuous universal," as distinguished from an intellectual universal. Hence, although we may not deny that the child groups common qualities for purposes of recognition, we must deny that it appreciates their significance as essential characteristics, as the notes which constitute the very nature of a countless multitude of objects. This full significance of the common qualities as necessary and universal the intellect alone can attain to. The product it works out is an abstraction that transcends the limitations of time and space. Recognition is confined to samenesses that have merely happened here or there, now and again; conception puts a value on the samenesses it abstracts, that is, it makes of them standards of design, ideals of existence good for all time and in all places. Consequently there is not simply a difference of degree between the sensuous and the intellectual universal.

The latter it not an outgrowth, a perfection of the former; they are two distinct species of cognition. The object of sense knowledge is always the individual, whereas the object of intellectual knowledge is the world of classes and orders.

CONCEPTUAL COGNITION IN SO-CALLED PERCEPTUAL EXPERIENCE. Once we grasp the full significance of the common qualities in an object the content of the concept thus obtained will not be absent from our ordinary perceptions of it. This is true, of course, only on condition that we are studying the object curiously and with full attention; in such case we bring all our power of knowing to the task, and the percept at this developed stage includes the content of the concept plus all the characteristics that are taken in through the senses. In other words, intellectual intuition seems to fuse with sense knowledge; and although the two processes are specifically distinct in nature, both are present when we perceive. Hence the common as well as the individual qualities of an object are grasped in one moment, though not one act of cognition, which, as a total experience, and notwithstanding the presence of conception, is usually referred to as a perception. Thus, if we study a plant in the garden, we should, while observing its individuating characteristics, be also aware that it possesses essential marks—namely, those that constitute plant nature; in other words we should besides perceiving it know it conceptually.

QUESTIONS

1. Explain what is meant by saying that percepts, images, and concepts are dynamic.
2. Where are these so-called products after the processes that form them cease?

3. Distinguish between perceptual and conceptual knowledge.

4. What is the object that attention is engrossed with in the case of sensory knowledge? In the case of intellectual knowledge?

5. What is necessary to the idea of "orders" or "classes"?

6. Give the meaning of "essence," "nature."

7. Define abstraction.

8. Show that mere recognition can account for the presence of "sensuous" universals, whereas abstraction—an intellectual process—is necessary to the formation of intellectual universals.

9. What is meant by saying that the concept carries us out of the present and transcends the conditions of time and space?

10. Is the concept a mere outgrowth of the "sensuous" universal, or has it a distinct value? Do these products differ in kind as well as in degree of application?

11. Explain the statement that there is conceptual cognition in perceptual experience.

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CHAPTER III

TERMS

LOGICAL MEANING OF TERMS. The term of any process is its conclusion, its culmination—the point towards which it tends and at which it is completed. Accordingly since thought does not reach its furthest end till it is communicated to others, its various terms are said to lie in the symbols of language. (With reference to thought, then, a term is the verbal expression of a concept.) A logical term may be a single word, as "trees," or a group of words, as "trees which shed their leaves in autumn." In a judgment one concept is compared with another and the result of the comparison is set forth in a proposition; more particularly, then, a logical term is the expression of a concept as used in an act of comparison, and hence is equivalent to the logical as distinct from the grammatical subject or predicate of a proposition.

GENERAL AND SINGULAR TERMS. *A general term is one that can be applied to each of all the members of a class.* It is, therefore, the verbal expression of the common qualities which make up the content of the universal or concept. *A singular term can be applied to but one definite thing.*

TESTS OF GENERAL AND SINGULAR USE OF TERMS. 1. When a term is a single word its character as general or singular can often be determined by employing the ordinary grammatical distinction be-

tween a common and a proper noun. Thus in the sentence "John is a lawyer," "John" is singular and "lawyer" is general.

2. Since, however, modifiers of a common noun may restrict its application from many things to one, and modifiers of a proper noun may extend its application from one to many, certain prefixes come to serve as tests for the general and singular use of terms. Thus "each," "every," "all," "some," and the negative signs of universality "no" and "none," cannot signify a singular term, whereas "this" and "that" cannot signify a general term. For example, "each man" is general but "this man" is singular: "Daniel" is singular without but general with the indefinite article, as in the exclamation "A Daniel come to judgment."

3. When neither the grammatical nor the verbal test above given can be applied, the only recourse is to discover the application of the term from its context. "Space," for instance, may be general or singular; it is general in so far as it includes some or all of the particular portions of space, singular in so far as it is used to denote the vast void within which the material universe is confined. "He who," "The law which," "The captain," may be singular or general, it cannot be said which unless there is some means of interpreting the thought of him who uses the expressions.

Peculiar difficulties seem to be associated with what have been called substantial terms, such as "water," "earth," "stone," and "oxygen." They are general inasmuch as they have physical parts and can take the prefixes "all" and "some;" they are singular inas-

much as they can be used in an abstract sense to denote the essence of the substances.)

COLLECTIVE TERMS. An assertion may be true of many things taken together and not true of any one of them; the subject of such an assertion is called a collective term. Words that denote aggregates or even scientific genera can be used in a collective sense. Thus, "regiment," "team," "flock," "library," may take predicates which could not apply to the individuals that make up these groups.

As employed in a proposition a collective term is always general or singular: it is general when it applies to each of all the aggregates it denotes, and singular, when it applies to one group only. For example, "flock" is general in the sentence, "A flock of sheep is a pleasant sight;" and singular in the sentence, "My flock of sheep will furnish a ton of wool."

COLLECTIVE AND DISTRIBUTIVE USE OF TERMS. Difficulties may arise unless it is definitely known that a given predicate applies to a group as such and not to each member of it. A term that can apply to each of all the individuals of a group or class is said to be *distributive*: if, in a proposition, it actually does apply to each, it is said to be *distributed;* if it is employed to indicate some at least, with or without the purpose of excluding all, it is said to be *undistributed*. Thus, "jewel" is a distributive term; it is *distributed* in the proposition "Every jewel is costly" and *undistributed* in the proposition "Some jewels are rare."

It is not always easy to say whether what seems to be a collective term may not really be used in a distributive application. Such a statement as "The team won the game" is plain enough, seeing that the vic-

tory must be attributed to the work of all the players together; but in the proposition, "All the team can lift this weight" the text does not reveal whether the subject stands for the team as a whole or for each member of it. Hence terms like "all the angles," "all the regiment," "all the men," should be carefully scrutinized because of their ambiguity.

The word "some" is similarly ambiguous; for although it is ordinarily prefixed to a term that is used distributively, this is not invariably the case. Thus, it forms part of a collective subject in the sentence, "Some of the boys (working together) built a bridge."

CONCRETE AND ABSTRACT TERMS. The distinction now to be considered rests primarily upon the following traditional definitions: A concrete term is the name of a thing or of an attribute considered as inhering in a thing; an abstract term is the name of an attribute considered apart from a thing. Thus, in the proposition "Caucasians are white," both subject and predicate are concrete, whereas in the proposition "Whiteness is a quality," both are abstract.

REASONS FOR DISTINCTION. The process of abstraction, since it is essential to the formation of all concepts, cannot be the basis for the distinction between abstract and concrete terms. "Man" is a concrete term, yet the content of its concept, "rational animal," stands for only a part of an object, namely, for a nature or essence which never exists except along with individuating charactertstics. Hence, although it is conceived as merely part of an existing whole, it carries a reference to existence in that whole. It is this *reference to existence*, possible or actual, which is the ground for dividing terms into abstract and con-

crete. In the case of an abstract concept, the intellect is absorbed with the attribute it is contemplating—concentrated attention is given to the very "whiteness" or the very "stillness;" indeed, consciousness is so filled with "whiteness," so filled with "stillness," that there may be no more room for understanding, but if there is more, it is for the understanding that no such objects as "whiteness" or "stillness" can have an existence of their own.

Pure abstract terms are said to be always singular, because in every instance the content of their concepts is an indivisible attribute—a bare meaning, restricted, definite, and therefore one.

ABSTRACT TERMS MAY BECOME CONCRETE. Terms that are primarily abstract, however, may be used in such a way as to make it impossible to regard them as anything but concrete. When this is the case one of the four following conditions is fulfilled: *first*, the abstract term is thought of as having subdivisions or variations; thus, "virtue" is divided into "justice," "prudence," "temperance," "fortitude"; "courage" is physical or moral; "darkness" has its degrees; "sound" and "color" have their changes of quality and intensity; *second*, the term is employed in the plural, as "colors," "evils," "heroisms"; *third*, it takes an individuating prefix, as "this freedom"; *fourth*, its predicate is concrete, as "Promptness is praiseworthy." In the last example "promptness" is concrete rather than abstract because it is conceived to be the subject in which "praiseworthy" inheres.

What should be specially noted in a consideration of abstract and concrete terms is that they often go in pairs. Corresponding to almost every adjective, indeed, there is an abstract noun; for example, "hard

—hardness," "sharp—sharpness," "cute—cuteness," "swift—swiftness." Such instances, in which attention shifts from a concrete to an abstract attribute are no more common than those in which the mind passes from a concrete essence or nature to an attribute conceived as signifying that essence or nature apart and in its entirety. Our language is full of illustrations: "devil—deviltry," "artist—artistry," "deacon—diaconate," "site—situation," "bishop—bishopric," "owner—ownership." However, there are cases in which the shift of attention is not indicated by a change in the form of the word, and, of course, confusion is the result. "Government," "religion," "beauty," "justice," are commonly employed in both an abstract and a concrete sense, and they and simliar terms frequently give rise to the material fallacy of Accident.

QUESTIONS AND EXERCISES

1. What is the general meaning of the word "term"?
2. Define a logical term, a singular, a general, a collective.
3. When a term is one word what tests may be employed to discover its singular or general use?
4. What are "substantial" terms? How should they be treated?
5. What is a distributive term? Is a distributive term always distributed?
6. Are both the italicized terms in the following sentence undistributed?—*Some of the boys* swam, while *some of the men* built a bridge.
7. Point out the singular, general and collective terms among the italicized words of the following examples. Say whether the collective terms have a singular or general use.

(1) *This paper* is white.
(2) *These boulders* weigh ten pounds.
(3) *The jury* may not bring in a verdict.

(4) *The audience* rose to its feet.
(5) *The committee* signed their names.
(6) *The present manager* is efficient.
(7) *Whosoever shall exalt himself* shall be humbled, and *he that shall humble himself* shall be exalted.
(8) *The last* shall be first and *the first* shall be last.
(9) *A flock of geese* is easily frightened.
(10) *The eldest son* is called the heir.
(11) *All the trees* give shade.
(12) *The team* had good class marks.

8. Define abstract and concrete terms.
9. Why are pure abstract terms said to be singular?
10. Why are attributive adjectives always concrete?
11. Give three concrete substantives that have distinct abstract forms.
12. What are the four conditions on which abstract terms become concrete?
13. Are the subjects of the following propositions abstract or concrete? Give similar cases of a twofold use of the same term.

(1) *Beauty* is a gift from heaven.
(2) *Beauties* may fade, but *this beauty* will endure.
(3) *Government* is essential to society.
(4) *Government* has sometimes usurped power.
(5) *Glitter* is sparkle.
(6) That *glitter* is characteristic of tinsel.

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CHAPTER IV

INTENSION AND EXTENSION OF TERMS

THE TWOFOLD USE OF TERMS. Terms, generally speaking, have both implication and application; that is, they possess a meaning, a content, and at the same time, reach out to one or more than one object. *The implication of a term is called its intension; the application, its extension.* The distinction is based upon the twofold function of conception which not only takes out of experience the common qualities that form an essence, but which also puts these qualities back into experience by pointing out the things that possess them, thus forming the classes of an ordered universe.

Primarily, of course, it is the intension of a term which controls its extension; for the problem of placing a particular thing is usually solved by discovering whether it possesses certain attributes or not. However, in a secondary way, extension may be a determinant of intension; for if a particular thing belongs unquestionably to a certain group and yet lacks an attribute which all the rest of the group possess, the probability is that this attribute should no longer be regarded as essential. Thus, in art, in science, and especially in ordinary conversation, extension is modified by intension and vice versa; one critic, for example, might contend that a given literary product cannot be classed as poetry because it lacks

regularity of rhythm and line structure, whereupon another critic might retort that the product is certainly poetry and that therefore the first critic's idea of poetry needs revision.

TERMS CHIEFLY INTENSIVE OR CHIEFLY EXTENSIVE. Although a term has implication as well as application it may nevertheless be so employed in a proposition as to attract attention primarily and chiefly to one of these phases rather than the other. A term is said to be used intensively when its implication is uppermost in the mind and extensively when its application is uppermost. Thus, in the proposition, "Birds are vertebrates" the subject is used intensively because it is "birds" as such, the nature of birds that the mind dwells upon, whereas the predicate is used extensively because interest centers mainly upon the group in which birds are to be included. On the contrary in the proposition "Frenchmen are polite" the subject points out certain individuals of a class, whereas the predicate leads us to think of a meaning, that is, a quality belonging to them. It is clear that either of these examples might support an opposite interpretation; accordingly the question whether a term directs attention to a meaning rather than an application must finally be decided by reference to the purpose of the statement. When the purpose is to note the presence of an attribute the statement is called a proposition of intension and when the purpose is to express class inclusion the statement is called a proposition of extension.

INTENSION OF PROPER NAMES. It is a disputed question whether proper names have intension, that is, whether their function is to do anything more than merely point out an object. Those who deny

that proper names carry any meaning, cite such an example as "Jack" and contend that the word by itself could be applied to a man, a horse, a dog. From this point of view proper names have extension but not intension; nevertheless they can hardly be used in an intelligible proposition without having some meaning *associated* with them. This associated meaning, however, may not be regarded as the counterpart of the term's extension in such a way that, given the extension, one definite meaning would be recalled, as the notion of a class is recalled when an individual is pointed out by a common name.

EXTENSION OF ABSTRACT TERMS. A question of an opposite sort arises in connection with abstract terms. Can they be said to have anything but intension? Certainly no objects corresponding to them exist, and the mind, while it contemplates them, seems to be suffused with simply the attribute that is considered apart. For instance, during the process of conceiving apart the attribute "white" consciousness is, as it were, all "whiteness;" and since there is no reference to existence the meaning has no extensive counterpart.

LAW OF INVERSE RATIO BETWEEN INTENSION AND EXTENSION. A peculiar relation between intension and extension is expressed in the law that as intension increases extension decreases and vice versa. For example, the term "man" has its proper intension and extension: take from its content the note "rationality" and there is left the note "animality" with an obviously wider extension; add to its content "white" and the term "Caucasian," thus obtained, is easily seen to have a more restricted application. It is clear from this example that when the law is applied to

terms in pairs or in a series they must display a class relation. In other words, the law means that if a given class name is considered, the class name which represents the next genus above it will have less intension and greater extension, whereas, the class name which represents a subordinate species will have greater intension and less extension. There is a gradual increase of intension in the following terms: "being," "substance," "body," "organism," "animal," "man," "John;" whereas, reading from "John" backwards, there is a corresponding increase of extension.

THE UNIVERSE OF DISCOURSE. 1. The created universe is looked upon as consisting of classes which in turn are composed of individuals. To know all existing things, therefore, a perfect conception of every nature and an accurate perception of every individual would be necessary; and corresponding to the intension thus found, the full extension of the created universe could be represented in a series of general terms and proper names. Now, by comparison with the whole created universe, each complete nature could be regarded as a little universe. For this partial, and sometimes fictitious view of the totality of creation, logicians have adopted the name "limited universe" or "universe of discourse."

Any ordinary general term will serve to illustrate what is meant by a "limited universe." "Man," for instance, by itself would constitute such a universe with, let us say, its sub-classes, "Caucasians" and "non-Caucasians"; while "man" and its coördinate "brute," would constitute a universe of discourse designated by "animal."

But even if the created universe could be comprehended we should inevitably imagine changes in it, additions to it. Giants, fairies, pigmies, and dragons would be thought about and talked about. As a matter of fact, poetry, fiction, art, and even science, is full of discussions about things which have no actual existence. Nevertheless, these things constitute universes of discourse within which predications are accurately said to be true or false. When, for example, it is asserted that "Hamlet is a more complex character than Othello," a statement is made which holds good in the universe of "Shakespeare's men."

It is evident that great care should be exercised in ascertaining the particular universe of discourse to which a given term applies. A few examples of how difficulties arise may prove helpful.

(1) A proposition such as "Everybody praises him" is frequently met with and seems acceptable enough for ordinary purposes. But how shall the statement be treated logically? "Everybody" is not only a distributive term but from the formal point of view is used distributedly, and yet plainly it is not equivalent to "all men" in the widest extension of that term. If it is to be taken universally at all,[1] it means *"everybody in a certain locality."* In thought, the limitation is undoubtedly made, but in language the corresponding prepositional phrase is left to be understood. Ellipses of this

[1] It would be used *particularly* if the statement were interpreted "practically everybody." In that case it would mean no more than "some." When this interpretation is possible the proposition is called "morally universal," and it should be remembered that the subjects of morally universal propositions are undistributed.

sort are features common to everyday conversation and even to literary composition.

(2) A person might argue that Brown is a gentleman because he is a student and students are always gentlemen; but it should be insisted upon that the term "students" here indicates a "limited universe," a universe of discourse which includes only *ideal students.*

(3) In the universe of melodrama, heroes are always rewarded, villians always punished; the case is by no means the same in the real universe.

QUESTIONS

1. Distinguish between the intension and the extension of terms.
2. Give a proposition in which the subject is used intensively and the predicate extensively.
3. What are propositions of intension? Of extension?
4. What is the reason for saying that proper names have no intension? If they have a meaning associated with them is it always the meaning of a particular class?
5. What reason is there for saying that abstract terms have no extension?
6. Explain why the so-called law of the inverse ratio between extension and intension applies only to terms that exhibit a class-relation with one another.
7. Illustrate the law by an example.
8. What is meant by a "limited universe," or a "universe of discourse"? Give an example of such a universe with its sub-classes.
9. Explain the application of "everybody" in the sentence "Everybody is going."
10. Is there a "limited universe" intended in the proposition, "A soldier will obey orders"? Would it be proper to cite in contradiction a soldier who failed in obedience?

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CHAPTER V

ABSOLUTE AND RELATIVE TERMS

DEFINITIONS. *An absolute term indicates a thing or an attribute considered in itself. A relative term indicates one of two things or attributes in such a way as to call attention to a characteristic which links the two things or attributes together.* The intension of an absolute term contains *all* the marks by which a thing or an attribute is known in itself; the intension of a relative term need not contain *all* the marks, need not, indeed, contain any of the marks by which a thing or an attribute is known in itself, but must contain that single characteristic which binds the thing or attribute to another thing or attribute.

Thus, "Patrick" is an absolute term, the intension of which implies the note common to all men plus those that are proper to the individual. "Father" on the other hand, is a relative term because it stands for an object which cannot be understood except as possessing a characteristic which necessarily links it with another object, "child." Its intension includes of course the notes essential to man, but what the intension brings out, what in fact makes the term relative, is the idea of "progenitor." "Cause" is a relative term also; its intension consists of only one note, namely, the idea of the "origin of an effect."

The characteristic by virtue of which an object or an attribute is thought to be necessarily connected

with another object or attribute, is called the *foundation of the relation;* a pair of things or attributes so connected are called the *terms of the relation* and are said to be *correlatives.* Examples of such terms are: "day" and "night," "means" and "end," "greater" and "less," "teacher" and "pupil."

CONVENTIONAL CORRELATIVES. There are certain cases in which although terms are used in pairs and seem to be understood with direct reference to each other, the exact conditions for correlatives are not fulfilled. In these cases standards, by no means constant for different occasions and different minds, are used as arbitrary measures of comparison. Thus, "hot" and "cold," "high" and "low," "big" and "little," can hardly be considered more than *conventional correlatives.* The test of conventional correlatives seems to be, not that each term of a pair implies the other—which is the test of true correlatives—but that each may be very well understood with reference to a third term within the range of the standard. For instance, "high" and "low" may be understood with reference to "higher" and "lower," "hot" and "cold" with reference to "hotter" and "colder," and "big" and "little" with reference to "bigger" and "less."

The use of conventional correlatives in argumentation is a frequent source of fallacy and confusion, hence care should be taken to define the "standard" and to keep it constant throughout a discussion. Thus before we could answer the question, "Is Logic more helpful to the student than mathematics?" we should have, at least, to discover (a) What is the help that each of these sciences furnishes, and (b) What the needs of the student might be.

ABSTRACT RELATIVES. The relation, rather than

the terms of it, is sometimes the prominent thought in the mind and to express this circumstance, we employ an abstract term such as, "friendship," "fraternity," "equality."

POSITIVE AND NEGATIVE TERMS. A positive term implies the presence of a quality or group of qualities, as "vertebrate," "entity;" a negative term implies the absence of a quality or group of qualities, as "invertebrate," "nonentity."

TERMS NEGATIVE IN FORM

1. CONTRADICTORIES. Two terms one of which is the simple negative of the other are said to be contradictories. Ordinarily a contradictory negative is formed by prefixing "not" to the corresponding positive; other prefixes and the suffix "less" may lead to confusion. Negatives formed by means of the prefix "not," are sometimes called *infinite* terms because their extension includes everything in the universe except the objects denoted by the corresponding positive. In order that one term may be regarded as the contradictory of another, two conditions must be fulfilled: (a) neither can apply to any object denoted by the other, and (b) both together must embrace all the objects in a universe of discourse. Thus "bird" and "not-bird" are contradictories because (a) the first will not apply to any of the objects denoted by the second and vice versa, and (b) every object in the universe of "animals" or even in the "unlimited universe," must be included under the one or the other.

2. CONTRARIES. Two terms are said to be related as contraries when (a) neither may apply to an object within a certain universe while (b) both

cannot apply to it at the same time: if (a) is the case, the object is properly denoted by a third term; if (b) is the case, the object denoted by one of the contraries cannot be denoted by the other. Thus, "pious" and "impious" are contraries: the one is the negative of the other for both can not apply to the same person at a given time; but both together might fail to include a number of persons who must, therefore, be designated by the third term "non-pious." Of course, strictly speaking, such terms as "impious," "unrest," "immoral," cannot be determined as contraries except through their meaning or matter; in form they are simply negatives and may even be sometimes interpreted as contradictories. It might be an aid to clearness if the distinction between these two kinds of opposition were illustrated by figures.

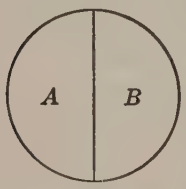

Fig. I.

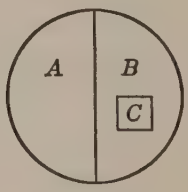

Fig. II.

Let the circle in Fig. I stand for a universe, limited or unlimited. Let section A of this circle include all objects possessing certain qualities not possessed by any of the objects in section B. Then from the point of view of this difference, any object must be in either section A or section B; that is, if an object is A it is also not-B, it cannot be A and B at the same time.

Again, in Fig. II let the circle stand for a given universe. Let sections A and B represent, as in Fig. I, contradictory classes, and let the square C include objects which lack, indeed, the qualities possessed by A, but which in addition possess opposite qualities. Then any object is either in section A or in section B; but objects in section B are thought of in two ways: all of them are thought of as not-A, that is, as lacking certain qualities of A objects; but some of them, namely, those within the square C, are thought of positively as possessing peculiar qualities of their own. From the relations thus illustrated it is plain: (a) that any object in A is not in B or C; (b) that an object might be in neither A or C; (c) that all the objects in A and C will not embrace the whole universe; (d) that some of the objects in B are also in C; and (e) that all the objects in C are also in B.

TERMS POSITIVE IN FORM

1. CONTRADICTORIES. A pair of terms may be related as contradictories even if both of them are positive in form. This is the case whenever the terms divide a class into two mutually exclusive parts. Thus, "male" and "female" in a sphere where there is sex differentiation, "plant" and "animal" in the sphere of living organisms, "domestic" and "foreign" in the sphere of commerce.

2. CONTRARIES. Two terms positive in form may also have the relation of contraries. This is the case when they denote classes which do not together exhaust a universe, but which display the greatest possible difference in the qualities they possess. Since contraries do not exhaust a universe, there must be at least a third class (a mean) to include the objects

that remain undenoted. It is characteristic of the mean that it possesses, besides the qualities common to all, none of the positive qualities proper to the extremes. The following pairs of positive terms display the relation of contraries: "wise" and "foolish," "high" and "low," "love" and "hatred."

REPUGNANT TERMS. Mutually exclusive terms which cannot be called contraries because they do not denote extremes and which cannot be called contradictories because they do not together constitute a whole universe, are said to be *repugnant*. Examples of such terms are to be found amongst names which designate the several members of a divided whole; the term which denotes one member is repugnant to any of the terms which denote the other members. So, "red" is repugnant to "green" or to the name of any other color; "porch" is repugnant to "door" or to the name of any other part of a house.

PRIVATIVE TERMS. In a general sense, the absence of a quality in a thing capable of possessing it is a privation, but in the logical sense a privative term suggests the absence of a quality which a thing ought by nature to have or which it would be in some way the better for having. In other words, the idea of loss is associated with every privative term. "Rudderless" is privative because a ship without a rudder has suffered a physical loss. "Colorless," as applied to a descriptive poem is a privative term inasmuch as the work is defective without color; whereas "colorless" as applied to a gas is simply contradictory, if it is the nature of the gas to be without color.

UNIVOCAL EQUIVOCAL AND ANALOGICAL TERMS. A term is univocal when it has only one meaning; the best examples of univocation are to be found in the

technical terms of science. An equivocal (or ambiguous) term may have two or more meanings and can, therefore, be properly applied to more than one kind of object. "Bill," for instance, may mean a resolution, a document, or the beak of a bird. An analogical term can hardly be said to have more than one meaning, for the thought it expresses is always some fundamental relation. It should rather be regarded as applying to unlike things, partly for the same and partly for a different reason. Any metaphor will afford an illustration. When, for example, the poet said "The ship plowed the ocean," he implied that the ship was a plow and the thought in his mind was that in spite of obvious differences, there was a fundamental sameness in the action of the two things.

QUESTIONS

1. Distinguish between an absolute and a relative term.
2. What is meant by the foundation of a relation? What are correlatives?
3. Name the correlative of "captain," "governor," "servant" and point out the foundation of the relation in each case.
4. What is the test of conventional correlatives?
5. If city life were to be compared with country life for comfort, what would be necessary in order to avoid confusion of thought?
6. Distinguish between positive and negative terms.
7. On what conditions may two terms be regarded as contradictories? Illustrate.
8. When are terms contrary? Give three examples.
9. Explain the statement that the contrary of a positive term is more than a simple denial.
10. Does a positive term and its contrary embrace all the objects within a given universe?
11. May two terms that are positive in form be related as contradictories? If so, under what conditions?

12. When are terms said to be repugnant? Give three pairs of repugnant terms.

13. Define privative terms. Is "lifeless" as applied to a stone a privative term?

14. Define and illustrate univocal, equivocal, and analogical terms.

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CHAPTER VI

THE PREDICABLES

FIRST AND SECOND INTENTIONS. In order to bring out the peculiar logical character of the predicables it will be helpful to draw a traditional distinction between first and second intentions. It should be noted to begin with that the word "intention" is used as synonymous with concept and term. We have seen that the function of conception is to afford an understanding of things. The intellect has power to reach out and come in contact with the classes that constitute the universe, and the process by which it does this is conception. Through the concept the intellect *intends* (stretches into) the very nature of things. Hence, concept as meaning, concept as carrying the mind to its object, has been called "intention." The object may be a class in the real order, or it may be the concept itself; it is, of course, first a class and afterwards the concept. A *first intention,* therefore, is the concept in so far as it carries the mind out to the external world. General ideas such as "tree," "spirit," and abstract ideas such as "honor," "whiteness" are thus concepts of first intention, which, it may be added, are also spoken of as direct or metaphysical universals.

But concepts themselves may, as we have said, become objects of study, and our attention may be concentrated upon the ways in which they stand to one

another. More particularly, it is the difference between their intension and extension that serves as a basis for this relation. For instance, we compare their intension and discover, let us say, that the meaning of one is implied in the content of another, as "animal" is implied in the content of "man"; or we compare their extension and discover that the application of one is wider than that of another, as "animal" is more far reaching than "man." Such relations as obtain between concepts have, of course, no external existence; but they are intelligible, they are true objects of thought; and because they are entities in the conceptual order, they may be regarded as "beings of reason," logical entities. The concepts that mean or intend these relations are called *second intentions.* They are also called reflex or logical universals to distinguish them from first intentions which, as we have seen, are direct or metaphysical universals.

Terms, the expressions of concepts, are subject to the distinction that has just been made and, from this point of view, are either of first or second intention. The terms we have been hitherto considering are of first intention because they carry the mind out directly to the external world; the terms we have now to discuss are of second intention because they turn the mind inward towards the conceptual order. Of course, any relation that may be found to obtain among concepts arises from the fact that they accurately represent things, so that ultimately, though indirectly, second intentions fulfill the general purpose of concepts which is to afford us an understanding of the world in which we live.

THE PREDICABLES AS ESSENTIAL AND NON-ESSENTIAL ATTRIBUTES. The second intentions

we are about to take up were called by Aristotle *"the predicables,"* a name which signifies *the class of concepts or terms that express the relation that obtains on the mental side between a predicate and its subject.* When two concepts are united in a judgment they make us aware of a fact, provided the judgment is true; but over and above this, they exhibit a peculiar relation growing out of a comparison of their intention and extension. Every predicate, it will be found, has one of five bearings upon a given subject: it is the subject's *species* or its *genus,* or its *differentia,* or its *property,* or its *accident.* Hence there are five, and only five, predicables. It is to be noted that in every case a predicate conveys what is to be said of the subject and amounts therefore to a qualifying element. But since quality is kind and kind implies class a predicate is always a universal.[1] Even in the proposition "Patrick wears good clothes," the whole truth is not grasped until the fact is brought out that "Patrick" is merely one of a number (a class) who wear good clothes.

Obviously what is said of a subject must reveal either its nature or something merely incidental to its nature; hence, predicates are *essential* or *non-essential.* Of essential predicates, there are three varieties: 1. SPECIES, which signfies the whole essence; 2. GENUS, which signifies the part of the essence that is shared by other subjects; and 3. DIFFERENTIA, which signifies the part of the essence that belongs to no other subject. Of non-essential predicables, there are two varieties: 1. PROPERTY, which, though not regarded as part of the essence, has nevertheless, a necessary

[1] Proper names are not true predicates because they simply denote, without directly qualifying, an individual.

connection with it; and 2, ACCIDENT, which is conceived as being possibly absent from the essence.

THE PREDICABLES DEFINED

1. SPECIES. *The species includes all the essential attributes of a thing, hence the intension of a species reveals all the notes without which the subject cannot be what it is,* and when these notes are formally expressed, the predicate amounts to a definition. For instance, in the statement "Man is a rational animal," the predicate, a definition, is an exact exposition of the species. In this case, and indeed in all similar cases, both terms of the proposition are specific; for if the predicate is the species expressed, the subject may be looked upon as the species compressed. However, a term in the predicable species is not synonymous with its subject when the latter is either undistributed or singular: such propositions as "Some animals are mammals" have a genus for their subject and such propositions as "John is a rational animal" are not definitions but imperfect descriptions which need to be filled out with salient accidental features.

2. GENUS. *The genus is that part of the essence which belongs to other species also.* Accordingly genus is a large class under which there are smaller groups called species. The genus is always given in a definition but the part of the definition in which it appears may likewise be used for the genus of another definition. Thus, a line is the *intersection* of surfaces; but a point, too, is an *intersection,* though not of surfaces.

3. DIFFERENTIA. *The differentia is that part of the essence which distinguishes the species from*

other classes. It can never, like the genus, be repeated in the definition of different subjects.

4. PROPERTY. *A property is that non-essential part of a subject which necessarily results from the essence.* The ability to cook, which belongs to man and only to man is an example. The property is said to be always present where the essence is and always absent from any other essence. Hence its extension is exactly that of the species. Mathematical concepts furnish the best illustrations of property. Thus, the definition of a triangle is "a figure bounded by three sides": it is a property of such a figure that all its angles are collectively equal to two right angles but this character, although it is true of no other figure, does not enter into the essence of a triangle.

The connection of the property with the essence is a necessary one, inasmuch as the property cannot be conceived as absent from the essence. The relation between the two is causal, that is, we think of the specific nature of the subject as engendering the property.

5. ACCIDENT. *An accident is that non-essential part of the subject which merely happens to be connected with the essence;* it is there, but since the association with the essence is casual, not causal, we can think of it as possibly absent. This account of accident is not metaphysical; from the metaphysical point of view a property would be an accident.

We distinguish between *accidents of the class* and *accidents of the individual.* To be born in Spain is an accident of Spanish people, to have a birthmark is an accident of the individual. It is sometimes said that individual accidents are essential to the individual; but this is only another way of saying that all

individuating characteristics are of their nature accidental.

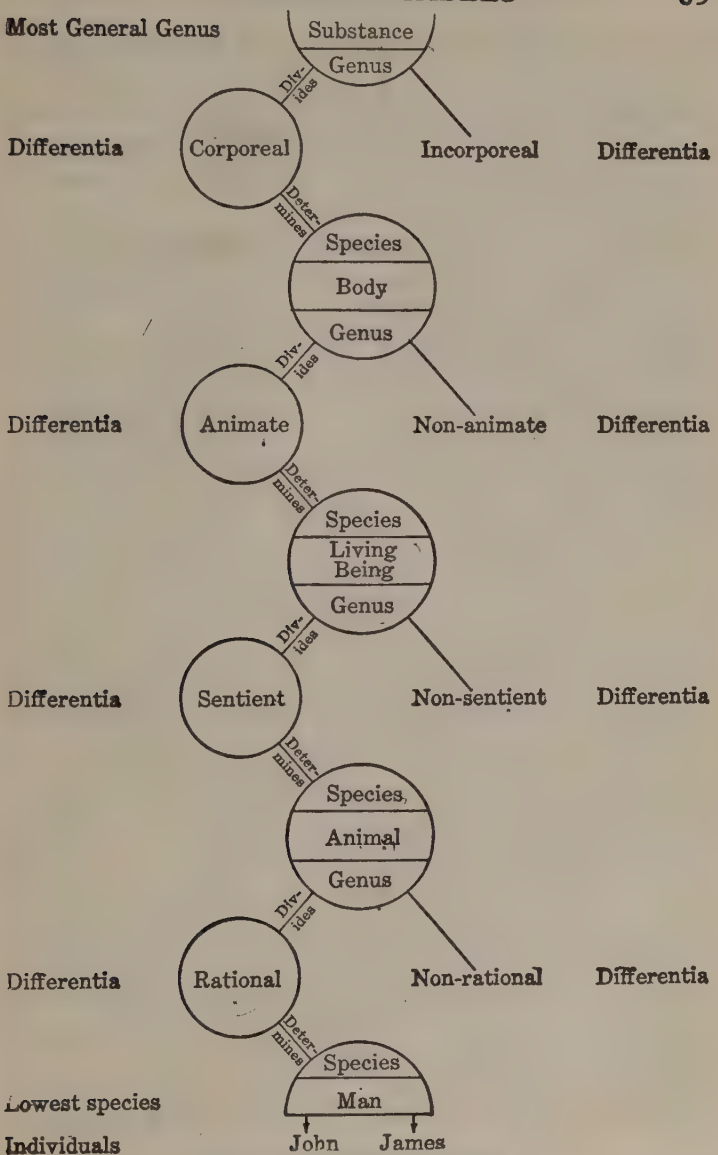
Accidents are also distinguished as *separable* and *inseparable*. Those that are separable are sometimes present and sometimes absent, as "sickness" in an animal, or "dryness" in a plant. Inseparable accidents are always present, yet are never thought of as necessarily connected with their subjects: the "blackness" of the crow is a good example.

INSEPARABLE ACCIDENTS AND PROPERTIES. What at one time is regarded as merely an inseparable accident may later be declared a property, provided there is good reason to think that it must be present as a necessary adjunct of the essence. A non-essential character can never be a property if, (a) it is found in other species, or if (b) it seems to have no causal relation with its subject.

THE TREE OF PORPHYRY. Some further relations between the predicables of the essence are graphically set forth in a diagram which Porphyry, a logician of the third century, devised to show the line of descent from the very general notion, substance, through less and less general notions, down to the individual. A modified form of the so-called Porphyrian Tree is given on the opposite page. It will be seen that the "tree" is rooted in the individual, "John" or "James" to whom, as we read upward, each notion within the "trunk" of the tree and each notion forming the left hand "branches," may be attributed.

RELATIONS OF THE ESSENTIAL PREDICABLES

The "tree" discloses some interesting facts about the three essential predicables; but its chief value consists in throwing light on the nature of logical sys-



THE PORPHYRIAN TREE

tems. It will be easy to understand syllogistic inference when it becomes clear that *the terms of an argument always reveal a part to whole relation (a system) in which what is characteristic of the logical whole, the genus, is seen to be a mark of the logical part, the species.*

1. GENUS. (a) Only the predicable "genus" can be applied to "substance," that is, "substance" is in the predicable "genus" and in no other. "Substance" is not a differentia, nor is it a combination of differentia and genus, that is, a species. This is so because "substance" denotes a class but never a sub-class; and, since it holds the place farthest removed from the roots of the tree in individuals, it is called the highest genus.[2] (b) Genus cannot be applied to "man" at all, since from the point of view of essential characteristics, there are no sub-classes under "man." (c) To all the intermediate notions, the term genus may be applied, seeing that each of them stands for a general class under which there are smaller classes, or to be more precise, seeing that the intension of each implies what is common in the species of which it is a part. Thus, "animal" is a genus with reference to "man" and all other sentient creatures; it is a species with reference to "living beings" which is its genus. (d) Any genus that is more extensive or "higher" than the genus from which a given species is immediately "derived" is said to be *remote* from that species. A *proximate* genus is consequently one from which a given species is directly "derived." Only the proximate genus may be employed in a logical definition.

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[2] For fuller explanation see section entitled "'Being' not a Genus," p. 47.

2. SPECIES. (a) Only the predicable "species" can be applied to "man;" that is, "man" lies in the predicable "species" and in no other. A predicate is said to be exclusively a species when its application is limited to individuals instead of groups, and from the point of view of essential characteristics there are no groups, but simply individuals, under "man." The term "man" on account of its position nearest the "roots of the tree," is called the lowest species. (b) Species is not exclusively applied to the intermediate notions between *substance* and *man;* for each of these is a genus with respect to classes below it and a species with respect to the class above it.

The law of inverse ratio, between intension and extension of terms is well illustrated in the Porphyrian Tree. As we ascend from "man" to the genera above, intension decreases by the loss of one note until we reach "substance;" and as we descend from "substance," extension diminishes by the loss of the groups of individuals successively indicated by the differentiae forming the right hand "branches."

3. DIFFERENTIA. A glance at the "tree" reveals the function of the differentia as twofold; for at the same time that it *divides* a genus, it *constitutes* a species. The differentia is the complement of the genus; both together coalesce in the essence, the genus as the determinable element, the differentia as the determining element. It is customary to speak of a specific as opposed to a generic differentia when the former divides an intermediate genus which, taken as a species, was constituted by the latter. Thus "rational" is the specific, and "sentient" a generic differentia of "man," because "rational" is the determining part of "man," whereas "sentient" is the determining

part of the genus above "man." It is clear, of course, that only the specific differentia can enter into a logical definition.[3]

QUESTIONS AND EXERCISES

1. Distinguish between a first and a second intention.
2. What is meant by the "predicables"?
3. Of the five predicables which are essential and which non-essential?
4. Define each of the predicables.
5. In what predicables are the italicized terms of the following propositions?
   (1) An organism is a *living corporeal substance.*
   (2) An organism is a *being that has vitality.*
   (3) An organism is a *corporeal substance.*
   (4) An organism is a *being that elaborates enzymes.*
   (5) A man is a *being that speaks.*
   (6) A man is a *being that has hair.*
   (7) Policemen are *tall.*
6. Give a property of a triangle, a square, an ellipse.
7. Construct the Tree of Porphyry.
8. What is characteristic of "substance" as the highest genus?
9. What is a remote genus? A proximate genus?
10. What is characteristic of intermediate genera?
11. Why is "man" called the "lowest species"?
12. Define a logical system.
13. What is the function of the differentia?
14. Give the specific and a generic differentia of "animal."

[3] To offset any confusion that might arise in the mind of a student of the natural sciences, it may be pointed out that the terms genus and species as employed in the predicables are relative. The same terms as employed in botany and zoology are absolute since they have a fixed place in the following familiar method of classification: (1) kingdom, (2) class, (3) order, (4) family, (5) genus, (6) species, (7) variety.

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CHAPTER VII

THE CATEGORIES

DEFINITION. The term "category" was employed by Aristotle to denote *a predicate considered independently of its use in a proposition,* that is, considered without reference to any one of the various subjects of which it might be asserted. The predicables, as we have seen, apply to predicates also, but only as related to a subject in a given proposition. Consequently, the categories are terms of first intention whereas the predicables are terms of second intention. Since the categories do not express relations between concepts they imply modes of being, and carry the mind directly to the external world. To know a concept as one of the categories, we need only consider it in the ordinary way, that is, as representing by itself a mode of external existence; on the contrary, to know a concept as one of the predicables, we must study it in relation, that is, as actually affirmed or denied of a definite subject. The predicate "animal," for instance, cannot be placed as a predicable until its subject is named—it is a genus if its subject is "man"; it is a species if its subject is "a sentient living thing"—but no matter what its subject, it is in the category of "substance."

"BEING" NOT A GENUS. The categories then are said to express modes of being. The term "being" since it has unlimited extension, is not a genus; for

we have seen that no predicate is a genus unless it can be determined by a differentia possessing a complete and distinct intension of its own, and there are no such differentiae outside of "being." To put the matter in another way, a term is never called a genus except in so far as it is a predicable, that is, except in so far as it refers to the subject of a proposition; and the intension of this subject (always a species or an individual of a species) is made up of two meanings, only one of which is identical with the predicate. Consequently if "being" were a genus, it could be predicated of a subject which would have two meanings one of which would not include "being"—a manifest impossibility. To illustrate: in the proposition "Spirit is a substance," the subject is a species, while the predicate is a genus, and it is plain that the intension of the former is greater by the inclusion of a note which does not belong to the latter. But in the proposition "Substance is a being," the subject is not a species because its intension does not imply two distinct meanings of which only one is identical with the predicate; and for the same reason the predicate is not a genus.

"BEING" IS ANALOGICAL. The fact is that "being" is analogical, that is, it applies to different things, partly for the same and partly for a different reason; and when it is used as a predicate, the mind is conscious of a difference as well as a sameness in the attribution. Hence, just as when we say "That book is healthy," we are well aware that the attribution is quite different from what it would be if we were to say, "That food is healthy," so when we say, "Substance is a being," we are likewise aware that the attribution is different from what it would be if we

were to say "Accident is a being." In other words if "being" is not generic but analogical, we have to *mean* its difference as well as its sameness when we use it as a predicate.

It follows that the differences in "being" are not discerned through an investigation based upon the question *"What is there in this that is not in that?"* for the question means "What entities do we find in the one object that are not in the other?" and if the objects are compared as simple "beings" the answer is "none." In fact, in any universe of discourse this question yields no answer whatever, unless the objects compared are species or individuals. For instance, in the universe of "sensible living beings," all things are generically the same, that is, no animal as such, is any more or less than another animal; specifically considered however, the animal "man" is seen to have an entity, "spirit," namely, which does not exist in any animal that is not "man." Hence in studying the differences of "being" the only purpose we can have may be expressed in the question, *"How does this thing possess its being as compared to the way in which that thing possesses its being?"* One answer gives us the distinction between God and creature: God possesses His being necessarily; creature, contingently. Another answer gives us the distinction between substance and accident: substance possesses being in its own right, not needing support from other beings; accident, on the contrary, requires that its being be supported.

THE TEN CATEGORIES

Substance and accident, therefore, are modes of being; that is, if we consider any being whatever with

reference to the manner in which it exists and apart from the question of whether it had or had not a beginning, we shall find it to be either a substance or an accident. There is only one way in which a thing can subsist, but there are nine ways in which a thing can inhere: consequently there are ten categories—substance and the nine accidents. Each of these predicates is in the predicable "genus" because each may be determined by differentiae; moreover each can be placed as a highest genus in an outline similar to the Porphyrian Tree.

1. SUBSTANCE *denotes a nature which stands of itself,* that is, a nature which so far as the mode of its existence is concerned, does not need to be supported. By contrast *an Accident denotes a nature which cannot stand alone, which therefore must be somehow supported.*

2. QUANTITY *is an accident by reason of the matter involved in the substance which supports it.* Spirits have no quantatative characteristics. This accident applies to extension in length, breadth and thickness, and is the basis of the division of material substances into parts.

3. QUALITY *is an accident which in a minor way tells us what a thing is.* It issues from the form or determining element of the substance; without the form a material substance could not possess the accidental determination "quality."

Quality is of four kinds:

A. *Habits and dispositions* of mind and body, such as health, knowledge of history.

B. *Natural powers and their strength or weakness,* such as, memory, intellect, hearing, muscular development.

C. *Sensible qualities* in the substance as a result of external powers acting upon it: for example, expressions of fear, paleness, coldness, heat.

D. *Figure,* the qualitative accident which determines the extension (quantity) of the substance; for example, the shape of a nose, the outline of a mountain.

4. RELATION *is an accident which determines the order or standing that obtains between two substances;* for example, two substances may be *similar* as to quality, *equal* as to quantity, the *same* as to their specific nature, or one may be the cause, effect, means or end of the other.

5. PLACE, *the accident which determines the location of a substance with reference to surrounding objects;* for example, "at home," "in Washington."

6. TIME, *the accident by which a substance is determined with reference to the course of events;* for example, "yesterday," "last year."

7. POSTURE, *the accident which determines the substance on account of the way its parts are related;* for example, "standing," "curled up."

8. ACTION, *the accident by which substance is determined as efficient cause;* for example, "striking," "lifting."

9. PASSION, *the accident by which substance is determined as the subject of changes produced from without;* for example "being hurt."

10. HABIT, *the accident by which a substance is determined by reason of the physical equipment it needs for living or working;* for example, "armed," "clothed."

It would be a mistake to confuse the predicable accident with the category accident. The extension

of the latter is far greater and includes not only properties but even characteristics that are definitely a part of the essence. This is particularly true of the categories "quality" and "action." Perhaps the following examples will help to make the point clear.

(1) "Figure," although in the category "quality," is often in the predicable "property"; and in the natural sciences where it is difficult to name essential features, classes are commonly distinguished by *figure;* for instance, forms of crystallization, shapes of leaves, and contours of bones, are frequently regarded as properties which throw some light on the essence of the things in which they inhere.

(2) In the proposition "He is cooking," the predicate is in the accidental category "action," but in the predicable "property," since the act of cooking is necessarily connected with human nature.

QUESTIONS AND EXERCISES

1. What is meant by a category?
2. Are the categories terms of first or of second intention? Give a reason for your answer.
3. Support the statement that "being is not a genus."
4. Why is "being" regarded as analogical?
5. In studying the differences of "being" what question should we ask?
6. What answers should be made to this question with reference to God and creatures, substance and accident?
7. Name and define the ten categories.
8. Give the categories of the following terms:
   sickness—blushing—extended—avoid—vision—like a ghost—Lincolnesque—greater than—afar—ship—next week — lying down — color — intellectual — insect — hatted—pulling—spurred (said of a rider)—wounded v-shaped—close—large.

9. Illustrate the distinction between the predicable "accident" and the category "accident."

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CHAPTER VIII

DEFINITION

EVERYTHING that has hitherto been said about terms may be regarded as a preparation for the discussion of definition and division. What a term applies to, no less than what it means, depends upon whether it is abstract or concrete, distributive or collective, a property or an accident, etc. And especially, the treatment of definition and division amounts merely to a more thorough study of the intension and extension of terms.

NATURE OF DEFINITION. A definition gives the meaning of a term; and since a term, either directly or indirectly, carries the mind to a corresponding thing, a definition, in every case, throws light on reality. Although we may be conscious that a definition does not go to the very heart of a particular essence, yet, if we are certain that our concept represents a class by serving to distinguish it from every other class, we may contend that we are in possession of truth so far as we have gone. Only classes can be defined; hence a definition is a direct answer to some such question as "What is a table? a tree? a man?" The answer has for its predicate the definition proper and for its subject the name of the class to be defined. If the question were, "Who is John?" or "Which dog is that?" the answer would be a de-

scription made up of the peculiar marks (always accidental) which serve to distinguish the individual.

A definition, then, embodies only those characteristics that are possessed in common by all the members of a class and by them alone. This condition is met by two sorts of characteristics; namely, the essentials and the properties of the species. Accordingly, from a strictly logical point of view, definitions are said to be either essential or distinctive.

ESSENTIAL DEFINITION. Since it is always a species that is defined, the predicables that constitute the species appear in a definition. Hence an essential definition contains simply the proximate genus and the specific differentia. In the definition of "man" as a "rational animal," "animal" is the proximate genus and "rational," the specific differentia. Mathematics furnishes numerous illustrations of essential definitions which are models of simplicity and clearness. The following is a definition of a square taken from *Webster's International*: "A parallelogram having four equal sides and four right angles."

CONVENTIONAL ESSENTIAL DEFINITION. The fact that the three great natural types—"plant," "animal," and "man"—are the lowest species in their respective lines of descent from substance, implies that from the metaphysical point of view there is in each of these classes an irreducible substantial form, or determining principle of existence, which is identical for every member of the species. Consequently, in essence one plant or animal or man is exactly the same as another and cannot be the subject of a definition. In other words, the metaphysician contends that whatever differences are discernible in beings under a lowest species must be gathered

from accidental qualities, and are therefore peculiar to the individual.

However, each of these lowest species (or even groups subordinated to them) may, by a convention, be regarded as a genus with specific differentiae made up of inseparable accidents. Hence such definitions as, "A Caucasian is a white man," "A bird is a feathered biped," "A church is a building to worship in," may be accepted as essential, though in reality they are descriptive.

DISTINCTIVE DEFINITION. This is the definition by property. It is defective in so far as it fails to declare what a species radically is. Moreover, it is defective as a basis for inference, for whereas it is comparatively easy to deduce a property from its essence, it is a difficult matter to deduce an essence from a simple knowledge of its property. Mathematical concepts readily lend themselves to a definition by property; for example, "A triangle is a figure in which the sum of the angles equals two right angles." In a distinctive definition the proximate genus need not be stated; the property and a remote genus or even the term "being" will suffice; for example, "Man is a being that laughs."

CAUSAL DEFINITION. Although all logical definitions may be said to express the cause of the thing defined (the reason why John or any other person is a man, for instance, is because he is a "rational animal"), yet there are two sorts of definition which seem to bring out this fact in a very prominent way and to which, therefore, the name "causal definition" is peculiarly appropriate. These definitions by final and efficient cause will on reflection be found to be cases of the Distinctive type.

1. A DEFINITION BY FINAL CAUSE *is given by pointing out the end for which a species is designed.* The definition is based upon the principle that if a thing is intended to do a certain kind of work, the performance of which is recognized as a property, we may conclude that it has a *capacity* for that work; and this characteristic in the category of "quality" will serve to distinguish it from everything else. Examples: A speedometer is a device for measuring the rate of motion; A chronometer is an instrument for measuring time; A key is a detachable instrument for operating a lock.

2. A DEFINITION BY EFFICIENT CAUSE *is frequently offered when the thing to be distinguished is a change wrought in some substance.* Such change is of course in the category "passion" and should, if possible, be in the predicable "property." Definitions by efficient cause are common in modern medicine, for there seems to be no better way of distinguishing certain diseases than by referring to the bacteria which produce them.

NOMINAL DEFINITION. When the derivation of a term, as distinct from the meaning of the thing it may stand for, is brought out in a proposition, the definition is said to be nominal. Thus, etymologically, pontiff signifies bridge-builder; humor, moisture; melancholy, full of black bile.

WORKING DEFINITION. Certain forms of explanation are sometimes used either because they possess some practical advantage over more precise renderings or because nothing better is attainable. They are at best merely provisional in character and are commonly known as "working definitions." The

chief kinds are Genetic, Descriptive, and Definition by Example.

1. GENETIC DEFINITION. The genetic definition describes the processes by which an individual of a type can be produced. What gives the description something of the import of a definition is the assumption that all other individuals of the same kind can be produced in the same way. Mathematical concepts are often defined genetically; thus, an angle is a figure made by producing two converging lines till they meet. Familiar examples are the recipes of cooks and the prescriptions of pharmacists.

2. DESCRIPTIVE DEFINITION consists in enumerating the parts which are supposed to enter into the composition of all the objects of a class. This form is practically the same as Partition, or Physical Division. It would be used by the psychologist who should explain that a perception is made up of several sensations, or by a person who should define a chair as "a moveable seat with four legs and a back."

3. DEFINITION BY EXAMPLE. Sometimes the only means of distinguishing objects is to point out individuals that illustrate the species or that possess the quality to be defined. For instance, there seems to be no other way of answering the question, "What is whiteness?" than by saying, "Whiteness is the sensation you have when you look at driven snow, a lily, clean linen, and the like." Again, poetry is hard to define exactly, but the reading of a truly poetic passage will greatly help a person to understand its nature.

RULES FOR DEFINITION

I. A definition should give the essence of a thing to be defined. As Stedman put it, "A definition de-

notes the species, the whole species and nothing but the species." The wording of this rule implies that all except essential definitions leave something to be desired. A definition is said to be *too broad* when it includes objects outside the species, and *too narrow* when it excludes objects within the species.

II. A definition should simplify and clarify the connotation of the term to be defined. This rule amounts to a caution against the use of obscure or ambiguous words. The caution was thrown to the winds by Dr. Johnson when he defined "network" as "anything reticulated or decussated, at equal distances, with interstices between the intersections."

III. A definition should aim to present the literal meaning; figurative language ought to be avoided. Little help to the understanding is derived from such a definition as, "Memory is the tablet of the mind."

IV. A definition should not contain words directly or indirectly implied by the term to be defined. It would be an offense against this rule to define a priest as a man who exercises sacerdotal functions.

V. A definition should not be negative when it can be positive. To say that one thing is not another is plainly to fall short of saying what it is. The rule extends to cases in which the predicate is not only negative in form, but also negative in meaning, as in the definition, "Life is the sum of the forces which resist death." There are two cases in which a negative definition cannot be avoided; namely, (a) when the term to be defined implies an incorporeal or unextended object, and (b) when it is negative or privative. An example of (a) is the definition of "spirit" as "an immaterial substance"; of (b), the definition of "blindness" as "the absence of vision."

QUESTIONS AND EXERCISES

1. What is the purpose of a definition?
2. How do you give an *essential* definition? Give one.
3. In *conventional* essential definitions what may be substituted for the proximate genus and what for the specific differentia? Illustrate.
4. What is meant by a *distinctive* definition? Give an example.
6. What is a definition by efficient cause? Give an example.
7. What is a nominal definition? Give an example.
8. Define and illustrate the three kinds of "working" definitions.
9. Classify the following definitions; should any be faulty, point out the defect by noting, if possible, the rule that is violated:

(1) A face is the window of the soul.
(2) A goat is a hollow-horned qualruped that feeds on refuse.
(3) Cork is a substance that floats on water.
(4) A teacher is a person who engages in pedagogical pursuits.
(5) A hypocrite is one who plays a part on the stage.
(6) Mush is a conglomeration of farinaceous nutriments.
(7) Typhoid fever is a disease that is due to the bacillus typhosus.
(8) A negative term is one that is not positive.
(9) A planet is one of the opaque bodies of the solar system that revolve around the sun.
(10) A book is a thing such as you are now engaged in reading.
(11) A comptometer is a mechanical device for adding, subtracting, multiplying, and dividing.
(12) A circle is a plane figure formed by completely revolving a straight line around one of its extreme points.
(13) A rabbit is a small furry quadruped with long ears and a short tail.

10. Construct definitions that offend against each of the rules.

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CHAPTER IX

DIVISION AND CLASSIFICATION

THERE are three processes of division named according to their objectives: Physical, Metaphysical and Logical. The first and second may be looked upon as phases of definition, for they are reducible to the analysis of the intension of a concept; the third, on the contrary, is opposed to definition, for it is concerned with the extension of a term to groups which constitute a distinct and modified whole. Let us consider the non-logical divisions first.

PHYSICAL DIVISION, also called Partition, breaks up a composite concrete thing into its several parts. Thus, a play is divided into acts; a poem into stanzas; a house into foundation, superstructure, and roof.

The utility of physical division can hardly be overestimated—a fact which becomes clear when we realize how much of our mental life involves the process of viewing parts in connection with a whole. Design, invention, indeed any sort of planning, presupposes a thorough study of part in relation to part and of these in relation to the unit they compose. Ordinary deliberation about our conduct would prove unsatisfactory unless due consideration were given to means as steps toward an end. Partition is employed by the builder in laying out his work; it is indispens-

able to the playwright in fashioning his plot; it is an aid to the lawyer in drawing up his brief, to the orator in marshaling his argument, to the painter in balancing his composition, and to the musician in apportioning his theme. The student, therefore, should cultivate the practice of making partitions of the various subjects he is engaged upon.

METAPHYSICAL DIVISION. This sort of division may also be called Partition; it differs from Physical Division only, as we have seen, in respect of the objects partitioned. Physical Division deals with singular things and with such general terms as are defined by description and consequently possess the features of individual wholes; whereas Metaphysical Division gives the structural components of such abstract terms as may be reduced to a species, a substance, or an accident. The three cases may be illustrated as follows: the *species* "human being" carries the two meanings of animality and rationality; the *substance* "gold" (considered abstractly) is solid, yellow, malleable, elementary, and a conductor of electricity; the *accident* "tone," in the category "quality," is made up of pitch, timbre, and intensity.

The point of view from which Physical or Metaphysical Division is made serves, of course, as the basis for the analysis. The bases most frequently employed are the relations of space and time, cause and effect. The relation of space is used in the division of a fountain pen into point, barrel, top, filling device; the relation of time is used in the chronological order commonly observed in narration; and the causal relation is used in treatises on the philosophy of history.

LOGICAL DIVISION. It has been pointed out that the function of definition is to break up the intension of a term which is always in the predicable "species"; by contrast, the function of logical division is to break up the extension of a term which is always in the predicable "genus." Hence, as in the definition the subject is a *specific* term, while the predicate is a combination of the genus and the difference; so in the proposition which sets forth a division, the subject is a *generic* term while the predicate names disjunctively the various appropriate species. Terms are disjunctively named by the use of the words "either—or"; as for example, "Animals are either rational or non-rational."

Division of any sort is said to be the separation of a whole into its parts; but it is necessary to distinguish between the logical whole and the physical or metaphysical wholes discussed above. (The following traditional tests may help to bring out the distinction: first, a logical whole can be predicated of its parts, hence we can say that all vertebrates are animals; second, a metaphysical whole cannot be predicated of its parts but the parts can be predicated attributively of the whole, hence although we cannot say man is rationality, we can say man is rational; third, a physical whole cannot be predicated of its parts nor can the parts be predicated of the whole, hence we can neither say a house is a roof nor a roof a house. Perhaps a more serviceable distinction is this: a logical part (species) carries the meaning of the whole (genus) but not vice versa, as elm would imply tree, but not tree elm; a physical or metaphysical whole carries the meaning of the parts, but not vice versa,

as a chair signifies "back," "seat" and "legs," but none of these connotes "chair."

Logical Division is something more than enumeration. To single out one after another the things that possess the nature of the genus would be to exemplify, not to divide, a generic term. In an enumeration, no matter how exhaustive, no new light could be thrown on the nature of the subject; in division, on the contrary, groups that result from analysis tell us something about the possibilities of the genus by exhibiting it in its various determinations. In this way, of course, logical division adds to our knowledge.

The sub-classes into which a genus is separated are called the dividing members of the division; they are always *coördinate* species, that is, species which besides being mutually exclusive, are collectively coextensive with the genus.

The means by which the mind is able to determine a logical whole by naming its parts is called the basis of the division, and is always the *specific difference*. In general, a difference is a quality or modification of a quality which is possessed by only some of a number of things that are otherwise identical. Thus, even if a considerable number of red cards were exactly the same in texture, shape, and size we could easily separate them into groups provided the redness of some exhibited a degree of saturation, tint, or shade that was absent from others. A specific difference, therefore, is a quality or modification of a quality which belongs to one but not to any other species of a given genus.

KINDS OF LOGICAL DIVISION

1. DICHOTOMY. The simplest, but by no means the most useful sort of division is *Dichotomy*, the sep-

aration of a genus into a pair of species, one of which is named by a positive term, the other by its contradictory. The division of "animal" into "rational" and "non-rational" is dichotomous; the divisions in the Porphyrian Tree also illustrate dichotomy.

The defect of this method of analysis is that in some instances (that is, whenever there are *more than two* sub-classes) dichotomy reveals only one species leaving the others confused under a blanket negative term. Of course this negative term may be divided in a similar way and there may be repeated division until the negative is exhausted; but there seems to be little advantage in working along these indirect lines, except in the exploration of new fields.

2. DIRECT LOGICAL DIVISION results from an immediate application of the determining principle to all the individuals of a genus. Thus, taste is divided on the basis of its qualitative differences into *sweet, bitter, salty, and acid.*

It should be recalled here that for purposes of scientific investigation when no true specific differences can be found, the substitution of a property or even an inseparable accident as the determining principle is permissible. Hence we may accept as logical such divisions as *man* into *white, black, yellow, red* and *brown.*

NATURAL AND ARTIFICIAL DIVISION. A distinction sometimes made between natural and artificial division merely serves to bring out the fact that occasionally the foundation of our analysis is arbitrary. In natural division the difference is a feature which would be likely to attract the ordinary observer, as for instance, the number of pistils in a group of flowers; in artificial division the difference is a fea-

ture that would ordinarily attract little or no attention and is obviously employed for a very special purpose, as for instance, the relative value of flowers in the trimming of hats.

The following rules amount to a summing up of our treatment of division:

I. *A division should be complete.* All parts of a whole should be enumerated so that the genus may be shown to be exhausted by the species named or, what comes to the same thing, so that the sum of the species exactly equals the genus in extension.

II. *There should be only one basis of division.* An offense against this rule results in cross-division. If the rule is carried out, the provision of Rule III will naturally follow.

III. *The members of a division should be mutually exclusive.*

Perhaps more important than any of these rules is the caution that the genus must be accurately defined before a division can be successfully carried out. However, the two processes go hand in hand, the one being a corrective of the other. The best way to check up on a definition is to attempt a division of the term defined; and similarly if a division is faulty or imperfect, its faults may be disclosed by means of a definition. Thus, if the definition of a genus were too broad, an attempt to divide it would reveal the fact that terms coördinate with the genus would loom up as species; for example, if house were defined as a "structure," bridges and tunnels (structures not houses) would probably come to mind. If the definition of the genus were too narrow an attempt to divide it would disclose the fact that at least some of the species would have to be excluded; for example,

if house were defined as a "dwelling," the mind would quickly discern that schools, churches, and factories, obviously in the class "house," were being overlooked.

CLASSIFICATION. Classification and Logical Division are much alike, yet they are not identical. The results of both as expressed in propositions are apparently the same—the setting forth of coördinate subclasses under a genus. But the means of obtaining these results are different. Division works from the genus out to the individual, classification from the individual up to the genus. Of course, neither division nor classification can proceed without generalization. When, as we say, we perceive a number of things together—plants, animals, men—grouping with reference to the most general notion has already taken place and we then go on to acquire more definite knowledge by forming smaller groups. When, for instance, we are in the presence of a crowd at a football game we may shift our attention from persons who are quiet to those who are noisy, from those who wear fur coats to those who do not, from the women to the men, from the players to the spectators, etc.; and this is classification. Viewed simply as a product, it is also division.

There is this difference between the processes: in classification we are dealing with the real order; it is the individuals that we put into classes and consequently the classes are concrete wholes that take their character from the individuals; in dividing, on the other hand, we are dealing with the conceptual order; beginning with a logical whole we aim to carry the meaning of this whole out to the groups and individuals that may bear it. In the one case the features of the individual define the whole, in the

other the features of the whole enter into the definition of the individuals. In classifying, the purpose is to mark the individual, to add to its significance; in dividing, the purpose is to bring out a characteristic of the whole, to show the capacity of the genus to share in the being of its several species.

QUESTIONS AND EXERCISES

1. Distinguish between Partition and Logical Division.
2. What is the difference between a physical and a logical whole?
3. What bases are most frequently used in partition?
4. Give the physical division of this chapter.
5. Give the metaphysical division of "organism."
6. How is a logical division set forth in a proposition?
7. Show that logical division throws some light on the character of a genus. Would complete enumeration of the genus accomplish the same purpose?
8. In what predicable are the sub-classes into which a genus is divided?
9. In what predicable is the basis of a logical division?
10. Define and illustrate Dichotomy. What is its advantage? Its limitation?
11. Define and illustrate Direct Logical Division.
12. How may Natural be distinguished from Artificial Division?
13. Criticize the following divisions; give the basis (or in a case of cross-division the bases) of division; if the division is faulty state the rule that is violated.
    (1) History into ancient, medieval, modern and current.
    (2) Poetry into lyric, dramatic, and didactic.
    (3) Books into printed and blank.
    (4) Saints into martyrs and confessors.
    (5) Human acts into good and bad.
    (6) Boats into rowboats, sailing vessels, and steamers.
    (7) Energy into kinetic, molecular, vital, and psychical.

(8) Physicians into skilful, sociable, honest, and negligent.

14. Give a dichotomous division of the students in your school.

15. Divide aircraft, railroad traffic, logical terms, athletic sports, eating utensils, novels, prose forms, blood-relationships.

16. Show that the definition of a term controls its division and vice versa.

17. Why should not a division of the term "scientist" include "Christian scientist"?

18. Explain the distinction between division and classification.

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CHAPTER X

THE LAWS OF THOUGHT

THEIR NATURE AND FORCE. The end of Logic is to discover and apply the laws of thought. With this purpose in view investigation of the processes of thinking could hardly advance far without laying bare a number of rules looking toward the attainment of truth. A discussion of terms, for instance, brings out the law of inverse ratio between their extension and intension and the rules for definition and division. Now it would seem natural that these rules should manifest a certain interrelation, that some should be corollaries of others, that some should be special and others general. This at any rate is the fact. Not only all thinking within the sphere of Logic but all thinking whatsoever is found to be reducible to four ultimate truths, called respectively the Law of Contradiction, the Law of Identity, the Law of Excluded Middle and the Law of Sufficient Reason.

These universal standards of criticism are laws of thought because they are laws of being. Truth, as set forth in the judgment, is said to strike an exact balance with reality, for whatever is in thought is, by virtue of being true, in things also. Consequently the principles of knowledge derive validity from their exact correspondence with the existing universe. From the logical point of view, however, they are regarded as norms, as guides to reasoning, as guarantees of

truth, as conditions which must be met if the end of knowledge is to be reached.

To say that these principles are "norms," "guides," "standards," with which our thinking *ought* to conform, is not to suggest the possibility of rejecting them; the meaning is simply that *if* the laws are not applied truth cannot be attained. We speak of the rules of rhetoric and the canons of art as *normative* also, yet we admit a certain freedom in the observance of them. A person may choose to be negligent in his speech or he may show little inclination toward artistic expression; but no one can help thinking, no one indeed can help doing his best to think correctly. We are driven to seek the truth by an impulse which, as a rational urge, is incomparably more constraining than mere animal instinct. Hence if one is conscious of the laws of thought at all, one is obliged to live up to them as the only means by which the impulse to seek after truth can be satisfied.

These laws are of course necessary; they offer no alternative and consequently compel assent. Attempts to deny them result in absurdities; in fact, the opposites of them are unintelligible. They are self-evident and cannot be other than they are, seeing that things cannot be other than they are. They are primary and fundamental; for since on the face of them they are true, they are not based on anything clearer or simpler.

THE LAW OF CONTRADICTION is usually stated as follows: *Contradictory propositions cannot both be true.* The principle must be understood of course to refer to our thought about a single subject at a given time. The metaphysical expression of the law is usually given in the statement: a thing cannot be and

not be. Aristotle's logical formula, "The same attribute cannot at the same time be affirmed and denied of the same subject," becomes ontological when it is expressed thus: the same attribute cannot at one and the same time both *belong* and *not belong* to the same subject.

The law may be symbolized in three ways: first, A cannot be and not be, when only "being" is predicated; second, A cannot be A and not be A, when the predicate is thought of as cointensive with the subject, as in definitions; third, A cannot be B and not be B, when the predicate denotes an attribute less intensive than the subject.

The Principle of Contradiction is said to be more universally applicable than any other because it seems to apply with peculiar directness to existential propositions, that is, those which assert "being" without naming a predicate attribute. Examples of such propositions are: God is; man exists. As we shall see, these cases are not so neatly covered by the Law of Identity except through an interpretation of it which hardly escapes tautology.

Although the law as stated, makes explicit reference to contradictory propositions, it applies with even greater force to contraries. It is not, therefore, to be taken as a test of contradictory opposition only. A better name for it would be the Law of Negation. It merely declares the impossibility of thinking that a subject which is entitled to a certain predicate is at the same time not entitled to it. There is, of course, no implication of doubt; what is forbidden is the attribution of incompatible qualities to the same object at the same time. Hence if we are convinced that all men are mortal, the law inhibits us from think-

ing the contrary, "No men are mortal," as well as the contradictory, "Some men are not mortal."

THE LAW OF IDENTITY. This principle has received various expressions and two of them at least can hardly be explained in the same way. There seems to be a difference in the formula attributed to Leibniz—*Everything is what it is;* and the formula which Locke originated—*Whatever is, is.* The obvious meaning of Locke's statement is: That which has being, has being. At first sight this pronouncement might appear to be a valuable criterion of existential propositions, but a little consideration will show it to be tautological and so quite useless for logical purposes. The Leibnizian formula gives us warrant for saying of a thing all that its nature implies: thus it is far from being tautological, for the very purpose of employing it is to cover cases in which there is diversity along with identity. Apart from truisms and careless utterances, when one reasonably insists on affirming sameness one commonly does so in the face of glaring differences. For instance, to declare a certain flower an orchid would be trivial unless it were done in spite of reasons which would give color to the contention that it is not an orchid. Again, from time to time a thing might present differences without forcing us to regard it as anything but itself. Hence the law safeguards us in asserting identity amidst differences and permanence amidst change.

The law is often expressed in the proposition, A is A. This symbolization may be regarded as adequate, provided it be not taken to stand for such truisms as "John is John." It has its best illustrations

in definitions. In the statement that man is a rational animal the predicate *explains* without *reiterating* the subject. Yet the true value of the Law of Identity is just as clearly brought out in the formula "A is B"; for this symbolization adequately represents the familiar case in which the predicate of a judgment has a greater extension and a lesser intension than the subject, as in the proposition, "Granite is hard."

THE LAW OF EXCLUDED MIDDLE states that *of two contradictory propositions, one must be true, the other false.* This is merely a logical way of saying that a thing must either be or not be, that it must possess or not possess a certain attribute. This law, unlike the law of contradiction, applies only to contradictory propositions. Between the two extreme instances represented by contrary propositions, there is a third possibility, a mean, or a "middle" which is not excluded. The two statements "All lawyers are honest" and "No lawyers are honest" might both be false; but if they were, statements not so extreme as either, namely, "Some lawyers are honest" and "Some lawyers are not honest," would be true. Again, between the contrary terms "wise" and "foolish" there is a middle term—either "not-wise" or "not-foolish" —which is not excluded from our thinking about a certain subject when they are excluded. Between contradictory propositions and contradictory terms, however, a middle must be always excluded.

The symbolization of Excluded Middle may be given in two ways: "A is either A or it is not A" and "A is either B or it is not B." The law is evidently applicable to cases of doubt and in such cases of course it restricts our thinking to alternative propo-

sitions. As the Law of Contradiction prevents us from thinking that an attribute and its negative can both be present in the same subject, so the Law of Excluded Middle prevents us from thinking that an attribute and its negative can both be absent from the same subject.

THE LAW OF SUFFICIENT REASON. A fourth principle of knowledge, the Law of Sufficient Reason, is stated by Leibniz in his *Monadologie* (§ 31) as follows: *"Whatever exists, or is true, must have a sufficient reason why the thing or proposition should be as it is and not otherwise."* The law evidently originates in the conviction that the quest for truth is not fruitless, that therefore not only is certainty attainable but also satisfactory explanations are possible. An assertion that is not true cannot be supported, and the failure to furnish a sufficient reason for it compels its rejection. Accordingly, a sufficient reason is a test of truth.

With reference to things it may be said that God as the Necessary Being contains in Himself a sufficient reason for His existence; an explanation for the rest of the universe must be sought in Him as First Cause. With reference to propositions it is to be noted that some—for instance the laws of thought, axioms, analytic propositions—carry in their very statements satisfactory evidence of their truth, whereas others do not demand immediate assent and consequently impel us to seek their sufficient reason in truths outside themselves, that is, in premises. But always, the law assumes that such premises are discoverable, and thus the principle besides being a safeguard, is a stimulus to persistent thinking.

QUESTIONS

1. Show that the laws of thought are also laws of being.
2. In what sense are the laws of thought normative principles?
3. Why are the laws necessary? Why are they said to be primary and fundamental?
4. State the Law of Contradiction from the metaphysical as well as the logical point of view.
5. In what three ways may the Law of Contradiction be symbolized with reference to different kinds of predication?
6. What is meant by saying that the Law of Contradiction applies with peculiar fitness to existential propositions?
7. Does it apply to contrary propositions?
8. What is the statement of the Law of Identity according to Leibniz? According to Locke?
9. Which of these is preferable? Why?
10. How is the Law of Identity symbolized?
11. State the Law of Excluded Middle.
12. Does this law like the Law of Contradiction apply to contrary propositions?
13. Explain its application.
14. Give its symbolization.
15. Can an attribute and its contradictory both be absent from the same subject?
16. State the Law of Sufficient Reason.
17. Why is the Law of Sufficient Reason a test of truth?
18. What propositions have in themselves a sufficient reason to compel assent?

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CHAPTER XI

JUDGMENT AND PROPOSITION

WE have next to consider judgment, the vehicle of truth and the instrument of inference. We have seen that concepts could not be discussed without frequent reference to their function as subject and predicate in the judgment. We have been obliged, therefore, to assume a distant acquaintance with the process we are now to view at closer range.

DEFINITION. *Judgment is the act of affirming or denying a predicate of a subject.* That it is an act, a single effort of the mind, should never be lost sight of. Like conception it is not static but dynamic. In the case of conception there is the word "concept" to signify the process from the viewpoint of what it accomplishes; in the case of judgment, we have only the one word, aside from the participial form, to denote both the process and the so-called product.

JUDGMENT NOT SENSE DISCRIMINATION. Judgment is a purely intellectual act and is to be distinguished from sense discrimination. Animals have the power not only of perceiving but also of recognizing objects; consequently it must be granted that they can communicate the fact of their sense discrimination by means of reactions—their cries, their approaches, their flight, and their attitude of combat. It would be easy to speak of the mental processes

which precede such reactions as "germs of judgment," but the phrase would be altogether misleading. A germ has within itself the power to develop under favorable conditions into a perfect thing of its kind. But the differences which animals are aware of lie in the realm of the senses, that is, they are always reducible to distinctions between qualities or intensities of particular sensations; and just as it would be erroneous to say that sensations are the germs of concepts, so it is incorrect to assert that sense discriminations are the germs of judgment. The material of the judgment, then, is the concept, the result of intellectual abstraction and intuition.

JUDGMENT AND COGNATE PROCESSES. Judgment is also to be distinguished from intellectual acts which are not assertive; for a judgment declares a truth, whereas the most that can be said of the acts in question is that they imply a state of mind which can be expressed in a declarative way. Hence we do not judge (a) when we ask a question, (b) when we request a favor, (c) when we give a command, (d) when we express a longing, or (e) when we utter an exclamation.

JUDGMENT A COMPARISON OF CONCEPTS. In every judgment there is an attempt to match one concept with another and our success or failure is expressed in an affirmative or negative proposition. The concept held in the mind and thought about is the subject; what is thought about it is the predicate.

We have had need to take account of both these elements in our treatment of terms. We have considered potential predicates in the categories and actual predicates in the predicables; we have seen that the same term would be a genus if applied to one

subject and a species if applied to another. It is important now to ascertain exactly what goes on in the mind when we judge.

It should be observed first that normally judgment cannot take place unless there is something to affirm or deny; unless, in other words, we have a fund of concepts at our disposal. Every item in this fund is a universal the content of which is made up of essential characteristics, the material of a definition. Moreover, there is linked with each a name into which, as it were, the meaning is compressed. These concepts are not literally stored in the memory: they have potential existence inasmuch as the mind is capable of thinking them and they have actual existence only while they are being thought. Nevertheless we may rightly say they are part of a man's mental equipment; in fact their number, their accuracy, their availability for use are the measure of a man's learning.

Of these concepts any one may be a subject for further thinking and any other may be compared with it as predicate. In the resulting judgment the subject-concept may be singular or general. When it is singular, it has as a rule been made the center of interest through stimuli coming from a particular object.

Let us take a simple instance of this sort and see what factors are at work. An object in the shadows of the dusk attracts our attention. We are curious to know what it is. There is present in consciousness a color, a shape, a size, and immediately the intellect fuses with these sense qualities its most general concept "being;" then this much of the experience is expressed in the term "That (thing)," the object of our curiosity. Our attempt to identify the object may in

the natural course of the association of ideas bring up for comparison the general notion of a "post." This general notion, drawn from memory and characterized by images of color, shape, size, location, and immobility, we try to match with the color, shape, size, location, and immobility, already present in the mind as the result of stimulation. Suppose we are conscious of their sameness, then this consciousness is the judgment which may be expressed in the affirmative proposition, "That thing is a post." Suppose we are conscious of their dissimilarity, then again this consciousness is the judgment which may be expressed in the negative proposition, "That thing is not a post." Suppose we are in doubt, then the mind suspends judgment. In the last case the color, shape and size of the thing are still present as sensations; and the color, shape and size belonging to the concept drawn from memory, are also present as images; but upon the question of their identity or non-identity, there is no decision. A nearer approach to the object followed by more distinction in the sensations may enable us to resolve the doubt, to make a decision. What this reference to an instance of doubt brings out is the fact that the essence of judging lies not so much in the process of holding the subject and predicate side by side in the mind (though of course there could be no judging otherwise) as in *seeing* the likeness or unlikeness between them. Such vision of the true relation of subject and predicate is the very act of judging.

THE SUBJECT AS LIMITED BY THE PREDICATE. The way in which the mind, while judging, thinks of the subject, is a feature that should not be overlooked. Whether the subject as a whole or some

quality of it is the center of interest can often be gathered from the predicate. Thus the proposition "That man is gray" tells us that in arriving at the truth the mind singled out the color of the man's hair to match with the abstract notion of "gray." But notwithstanding this analysis the facts that the immediate subject of the sense quality is the hair and the immediate subject of the hair is the man, were not lost sight of. Indeed the truth of these relations must have been perceived through judgments made beforehand, or there could be no warrant for using the term "That man" as subject of the proposition. This illustration throws light on all cases in which the subject is given a specific name; for in all these cases the employment of such a name implies a previous judgment. For instance, I cannot say, "This mushroom is edible" unless I have already said, "This is a mushroom."

JUDGMENT AND REALITY. The relation of subject and predicate in the judgment is always *real*. This does not necessarily mean that either the subject or the predicate exists outside the mind. It does mean that within a given universe of discourse—and all such universes have actual existence as matters which men talk about—the predicate really belongs or does not belong to the subject. That a dragon belches forth flames is as true within the realm of fable, as that birds actually fly or snakes actually crawl. It should be remembered therefore that judgments always refer us to things as they *are*, whether in the world of fact or fancy.

PROPOSITIONS. *A proposition is a judgment symbolized in words.* The words of course are arranged so as to convey a complete thought; consequently

corresponding to the subject concept there is a subject term, and corresponding to the predicate a predicate term. In addition there is a copula which stands for the mental act of affirming or denying.

It is worth noting that each part into which the proposition is separable really implies the other two. A subject is such by virtue of having something said about it; a predicate is such because it is attributed to something; a copula symbolizes a decision, but a decision is essentially the announcement of a perceived relation between two things. The fact of this inter-implication merely emphasizes the oneness of the conscious process which the judgment is.

THE MATTER AND FORM OF PROPOSITIONS

1. MATTER. *In general the matter of a proposition is said to be the terms considered out of relation.* Viewed thus as undetermined but determinable, they can conceiveably serve as material for any sort of comparison; for instance, "some angels" and "ministers of grace" can be judged to be identical or not. Moreover, while the kind of comparison remains the same a great variety of terms may be employed in particular judgments.

If however we regard the terms of a proposition, not as potential but as actual subject and predicate, we must consider them as *significant matter* and say of them that they demand one form rather than another. This is most obviously true in the case of analytic propositions; thus, given "a straight line" as subject and "the shortest distance between these two points" as predicate, the copula must be "is."

2. FORM. *The form of a proposition is its determining element, the copula.* As we know, any term that is not significant matter may be conceivably linked by affirmation or denial with any other term as subject or predicate. Of course whether two terms are thus associated or not depends upon our insight into their true relations; but if one of two terms is judged to be affirmable of the other the fact of this relation is expressed by the copula "is" and if the contrary is the case, the copula "is not" symbolizes their incompatibility. It is because the affirmative and negative copulas tell us how terms stand towards each other that they are called the form of propositions.

Another use of the word "form" in connection with propositions makes it apply to the extension of the subject as well as to the copula. From this point of view the form would depend not only upon whether the copula were affirmative or negative but also upon whether the subject were distributed or not.

QUESTIONS

1. Define judgment.
2. Show that it is specifically distinct from sense discrimination.
3. Are the sentences, "Come here," "Ah me!", "Is he home?", judgments?
4. How would you define the logical subject and predicate?
5. Under what headings have we already considered potential and actual predicates?
6. What is meant by saying that "normally judgment cannot take place unless we have a fund of concepts at our disposal"?
7. Describe in detail what goes on as the mind forms the judgment, "This stone is heavy."
8. What is implied with reference to the subject in the statement, "This stone is heavy"?

9. What is meant by saying that "judgments always refer to things as they *are*"?

10. Define a proposition.

11. Explain the interimplication of the three elements of a proposition.

12. In general what is meant by the "matter" of a proposition? What is "significant matter"?

13. What is the "form" of a proposition?

14. Does the question of whether the subject is distributed or not sometimes enter into the determination of "form"?

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CHAPTER XII

KINDS OF JUDGMENTS AND PROPOSITIONS

It should be understood that when we speak of propositions we also have judgments in mind. In fact, occasionally at least, the exact import of a proposition can be grasped only be refering it to the mental act of which it is merely the symbol.

Propositions are distinguished according to *quality, quantity,* and the *relation of subject and predicate.* The following divisions result from the application of these bases:

I. Quality yields
   (1) Affirmative—S is P.
   (2) Negative—S is not P.

II. Quantity yields
   (1) Universal
      (a) General—Every S is P.
      (b) Singular—This S is P.
   (2) Particular—Some S's are P.

III. Relation yields
   (1) Categorical—S is P; S is not P.
      (a) Analytic
      (b) Synthetic
   (2) Hypothetical—If S is M it is P, or if A, then C.
   (3) Disjunctive—A is either B or C; also other forms.

I. THE QUALITY OF PROPOSITIONS

The quality of a proposition is an accident of its form and depends upon the nature of the copula. We

may say of any term that it may be conceivably linked by affirmation or denial with any other term as subject or predicate. But whether two terms are thus associated or not depends upon our insight into their true relation. If one of them taken as predicate is judged to be attributable to the other taken as subject, the fact of this relation is expressed by the word "is"; if the contrary is the case, the word "is not" expresses the relation of incompatability. Hence it is the copula which determines how two given terms stand towards each other, and for this reason it is said to constitute the form of a proposition. Since, however, quality in general is a modification originating in form, the quality of a proposition is known from the copula. The words "is" and "is not," then, are the marks by which the affirmative and negative character of propositions is determined.

DIFFICULTIES IN ASCERTAINING THE QUALITY. This kind of division offers no important theoretical problem, but practical difficulties often arise through our inability to decide whether the copula is affirmative or negative. A decision to this effect, however, must be made before the question of quality can be settled. It is the particle "not" which causes all the trouble. Naturally when "not" expresses part of the negative copula it should modify "is," and naturally also in that case it should have place immediately after "is." But in the English idiom, "not" has a tendency to float and there are (a) instances in which, though placed after "is," "not" really modifies "all" or "every" in the subject term, and (b) other instances in which "not" may belong to either the predicate or the copula, one can hardly say which. "Every painting is not a masterpiece" exemplifies (a);

and the difficulty encountered in cases of (b) may be illustrated by the proposition, "A spirit cannot be seen." In the first example, since "not" plainly modifies "every," the proposition as stated is affirmative and should read: "Not every painting is a masterpiece." In the second example the copula is hidden, and there is doubt whether it should be expressed affirmatively, as in the sentence "A spirit is a substance which cannot be seen," or negatively as in the sentence "A spirit is not a substance which can be seen." The first example (a) shows how the form is conditioned by the matter of a proposition—for until we ascertain whether the subject is distributed or not we cannot determine the quality; the second (b) shows that it is impossible to decide upon the quality unless we know exactly how the terms of the proposition are conceptually associated.

II. THE QUANTITY OF PROPOSITIONS

The quantity of a proposition is an accident of its matter; hence the complete quantity includes the extension of the subject and predicate terms. Yet it is not the complete but a partial quantity—namely that of the subject—which logicians employ as a basis of classification. In this restricted sense the quantity of a proposition depends upon whether the subject is distributed or not; if it is distributed, the proposition is universal, if not, the proposition is particular.

1. A UNIVERSAL PROPOSITION is one in which the predicate is affirmed or denied of the subject taken in its fullest denotation. The subject may be thus taken not only when it is a general but also when it is a singular term, and consequently universal propo-

sitions are subdivided into (A) those that are general and (B) those that are singular.

A. GENERAL PROPOSITIONS. If predication is made of every individual in a class, the fact is usually discoverable by means of certain signs of quantity prefixed to the subject term. These signs are "all," "each," "every" and sometimes "a" or "any," for affirmative propositions; and "all-not," "no" or "none" for negative propositions. It is advisable always to employ "no" or "none" as the sign of quantity in negative universals on account of the equivocation already noted which may arise from the use of "all-not." It should be borne in mind that "no" and "none" have a twofold function; they distribute the subject and at the same time negate the copula; hence, although the copula in propositions beginning with "no" or "none," may seem to be affirmative, it is really negative.

Not all general propositions have the same value as universal truths; for in some cases the word "all" is legitimately used only because a complete count of the subject has been taken, whereas in other cases it is properly used because the predicate is in the nature of things judged to be affirmed or denied of the subject. Thus when we state that "All the apostles were Jews," we merely announce that after having considered every person to whom the term "apostle" can be applied, we have discovered as a matter of fact that he was a Jew; but when we say that "Every molecule of water is composed of two atoms of hydrogen and one of oxygen," we announce a judgment that is true in spite of the fact that the counting of individual molecules is out of the question. General propositions whose truth depends upon counting may

be called *enumerative*, and those whose truth depends upon the fact that the subject by its nature must or must not take a given predicate may be called *expository*.

It is suggested that the form "All S's are P" be used for enumerative and "S as such is P" for expository propositions; as for example, "All the Senators were in evening dress" and "Birds as such are vertebrates."

General propsitions may become particular. Both enumerative and expository propositions may lose their universal quantity when there is substituted for the subject a term which is its genus, natural or artificial. Thus the enumerative judgment "All the apostles were Jews" may become "Some of the disciples were Jews" or "Some of the followers of Christ were Jews;" and the expository proposition "All men are rational" may become "Some animals are rational."

B. SINGULAR PROPOSITIONS are usually regarded as universal on the ground that a subject which denotes one object only is nevertheless bearing its fullest extension. In the sentence "Caesar was ambitious" the application of the subject cannot possibly be greater than it is. Even in such a statement as "One of you is about to betray me," the subject is definitely singular; for though its intension calls for further characterization, its extension is complete.

Propositions in which the subject is a collective term may be singular or general. They are singular when the subject denotes one group only; for example, "The college team was victorious;" they are general when the subject denotes every group of a

certain kind; for example, "All college teams are composed of amateurs."

2. A PARTICULAR PROPOSITION is one in which the predicate is affirmed or denied of an indefinite number of the class denoted by the subject. The accepted sign of particular propositions is the word "some." "Some" however, signifies quantity either by definitely restricting it or by leaving it indefinite. Thus we may say "Some metals are rare" and intend to exclude "all," or we may say "Some swans sing while they are dying" and intend to leave room for the possibility that all swans do so. If "some" means "at least one or more but not all," the proposition in which it is used implies another proposition opposite in quality; for instance, a chemist's judgment that "Some metals are rare" is probably accompanied by the thought that "Some metals are not rare." But it is this very implication that logicians wish to avoid; hence in its logical use "some" means "at least one or more, possibly all."

Other signs of quantity which, like "some" in its logical use, make the extension of the subject indefinite are "most," "many," "a few" and, by indirection, "few" and "not all." Thus, of apples in a barrel we may say, after an incomplete investigation: (a) "Most of the apples are ripe" not intending to deny that "All are ripe;" (b) "A few of the apples are ripe," meaning a few at least and perhaps, on further investigation, all; (c) "Few of the apples are ripe," implying by indirection that "Most (perhaps all) are not ripe;" and (d) "Not all the apples are ripe," indirectly announcing that "Some are not ripe." It will be seen from the last two examples that when propositions begin with "few" and "not all"

they should not be employed for purposes of reasoning until their quality is changed and their quantity made particular by prefixing "some" to the subject.

PARTITIVE PROPOSITIONS. Having noted that within the field of Formal Logic the quantity of particular propositions must be regarded as indefinite, we should not lose sight of the fact that much of our thinking involves the use of particular propositions whose quantity is comparatively definite. Such propositions we may call partitive. Partitive propositions have one common characteristic: their sign of quantity is equivalent to "one or more but not all," and consequently the class denoted by their subject is divided into two parts, one of which takes the predicate while the other does not. A partitive proposition always implies the truth of another proposition, its complementary, which is opposite in quality.

It may be useful to illustrate the several cases in which certain signs make the element of quantity comparatively definite.

(1) "Some" in its non-logical import breaks up a subject into two parts through a mental act that hardly differs from dichotomous division, by which, as we have seen, a genus is resolved into a pair of contradictory species. Indeed "some" could not signify "one or more but not all," unless the mind perceived that the predicate concept was related in one way to one part of the subject and at the same time related in an opposite way to the other part. It is this perception of a twofold relation of the predicate that gives the complementary character to all partitive propositions.

But since "some" thus separates a subject into a pair of mutually exclusive parts, these may be re-

garded as two species within a dichotomous division; and if one part were given a specific name and the other the contradictory of that name, both could be used as subjects with one predicate in two universal propositions that would be opposite in quality. For instance, taking as our complementaries: "Some men are charitable" and "Some men are not charitable," we could, by naming "selfish" as one species, resolve them into "No selfish men are charitable" and "All non-selfish men are charitable." Such substitution of distributive for undistributed subjects is equivalently if not actually made in exceptive and exclusive propositions which are discussed below in cases 7 and 8.

(2) "A few" may have the same non-logical import as "some" although the subject it modifies has much less extension than the subject of the complementary implied proposition. Thus "A few men have achieved undying fame" brings forward the truth that "Most men have not achieved undying fame."

(3) "Most" in its non-logical use quantifies the subject in direct opposition to "a few;" for example, the statement "Most of the poets are forgotten" stresses the fact that "A few of the poets are not forgotten."

(4) "Not all" is employed when the mind admits a given relation of predicate to a part of the subject, while indirectly denying the same relation of the same predicate to the remainder of the subject. Thus, if I wish to admit that "Some voters are intelligent" and yet to insist that "Some voters are not intelligent," I may do both indirectly by employing the form "Not all voters are intelligent." Accordingly when the sign "not all" is used the so-called

implied proposition—the one that bears the brunt of the thought—is always a particular negative.

(5) "Few" is used in the same way as "not all" except that the admitted relation pertains to the smaller part of the subject while the indirect denial of this relation applies to the greater part. Thus, if I wish to grant that "Some (a small number of) heroes are not modest" and yet to point out that "Some (the greater portion of) heroes are modest," I may do both indirectly by employing the form "Few heroes are not modest."

(6) Numerical expressions of quantity which limit a subject exactly or with approximate accuracy, are frequently the signs of partitive propositions. For instance if it is said that "Three-fourths of the chorus have good voices," it might seem to be implied that "One-fourth of them have not good voices." But this implication is not always warranted, for further investigation might show that "All have good voices"; in such case, however, the proposition should be classified not as a partitive but as an indefinite particular.

The remaining cases illustrate how the mind may deal in two different ways with identical material; for both the exceptive and the exclusive proposition express the same sort of fact. They each present a combined statement of a rule and its exception. Their difference is this: the exceptive proposition is a means of *asserting* the predicate of all of one species; the exclusive proposition a means of *denying* the predicate of all of one species.

(7) "All except" ("all but") is the sign of the exceptive proposition, an example of which would be: "All except mature persons believe in fairies."

In this example, the discourse is about "persons," and that term may be regarded as the genus. Were there no exception to the rule announced in the original proposition the predicate would be asserted of the whole class in the sentence, "All persons believe in fairies." It is seen however that a part of the genus cannot take the attribute and this limitation must be set down. The matter might be expressed in two particular propositions, as "Some persons believe in fairies" and "Some persons do not believe in fairies;" as it is, the speaker chooses to make the connotation of the generic parts more definite by stating one specific name and leaving the contradictory of it to be supplied—a procedure which enables us to regard the given exceptive as a combination of two general judgments; as for instance, "All non-mature persons (*i.e.* children) believe in fairies" and "No mature persons believe in fairies." Any exceptive proposition may thus be logically reduced to two particulars or resolved into two universals.

(8) "None but," "none except," "only," and "alone" are signs of the exclusive proposition. To show the intimate relation between the two forms we are discussing, let us employ the material we have just dealt with and take as our example of an exclusive proposition the judgment: "None but non-mature persons (*i.e.* children) believe in fairies." Here again in effect the genus "persons" is paired by dichotomy into "mature" and "non-mature." According to the rule as stated in the original proposition, it would be true that "No persons believe in fairies;" but an exception is noted in the very announcement of the rule, and since the purpose of the exclusive form is to deny the predicate of the whole of one species, the

most obvious interpretation of the combined statement is: "No mature persons believe in fairies." Nevertheless in expressing the exception we cannot employ a universal affirmative and say "All non-mature persons (*i.e.* children) believe in fairies;" because all that the original proposition achieves is the exclusion of "believers in fairies" from the total extension of "mature persons;" in other words, it does not succeed in including "all children" within the extension of "believers of fairies." Hence while it is true to say that "All believers in fairies are children" the most that can be inferred by converting this is that "Some (perhaps all) children believe in fairies;" accordingly the predicate but not the subject of an exclusive proposition is distributed.

MATERIAL PARTICULARIZATION. Although the foregoing treatment of partitive propositions assumes that their character as particulars depends upon a knowledge of their matter, what may be regarded as a special kind of material particularization occurs when a subject is quantified not through such formal signs as have just been considered but by means of a modifying word, phrase or clause. Taking as a subject the term "lamp," for instance, we could restrict it by prefixing the adjective "reading," by affixing the phrase "for reading" or by employing the relative clause "which is suitable for reading." The relative clause structure is perhaps the most difficult of interpretation, for it often happens that such clauses do not limit but merely describe or explain the terms they modify. For instance if a historian wrote, "All the soldiers who fought on foot attacked valorously" only the context could reveal whether all the soldiers who attacked valorously

were all the soldiers in the field or not; in other words, the relative clause might (a) note an additional fact about all the soldiers, or (b) restrict the quantity of the subject to some of the soldiers, leaving us to imagine the presence of artillery and cavalry.

For the solution of practical difficulties the following test may be helpful: if the clause is *explanatory* the original proposition may be resolved into two independent judgments which have the same subject: if the clause is *limiting,* the original proposition cannot be so resolved. Thus if the clause in our example were explanatory we could say, "All the soldiers fought on foot" and "All the soldiers attacked valorously;" if it were limiting the proposition would have to remain as it is and the quantified subject would be seen to provide for a distinction between the soldiers who fought on foot and those who did not.

UNDESIGNATED QUANTITY. In ordinary spoken and written language we sometimes find an unmodified general term standing as a subject; as for example. "Men are wise." Propositions in which such subjects appear are often called indesignate, and they should not be used for logical purposes until the quantity of the subject is ascertained. There are two cases in which the quantity of indesignate propositions seems rather to be taken for granted: first, in what have been called "generic judgments" the predicate is obviously a genus and can therefore be regarded as applying to the whole of the subject, hence such propositions as "Dogs are vertebrates," "Mosquitoes are insects" should be accepted as universals; second, in what have been called "moral universals" the predicate is seen to apply to the subject generally but not without exceptions,

hence such propositions as "Men love their native land," and "The Scotch are thrifty," should be taken as particulars.

THE FOUR SYMBOLS OF COMBINED QUANTITY AND QUALITY. Any proposition may have both its quantity and quality symbolized by one of four letters of the alphabet chosen from the first two vowels in *affirmo* for affirmative propositions and the vowels in *nego* for negative propositions. In addition, the first vowel in each word signifies a distributed subject, the second vowel in each an undistributed subject. Accordingly, A stands for a universal affirmative, I for a particular affirmative, E for a universal negative, and O for a particular negative. In setting forth the forms in this fourfold scheme of propositions the appropriate letter uncapitalized is sometimes substituted for the copula; thus:

A Every S is P; or S a P.
I Some S's are P; or S i P.
E No S is P; or S e P.
O Some S's are not P; or S o P.

III. KINDS OF PROPOSITIONS DEPENDING ON THE RELATION OF SUBJECT AND PREDICATE

The most important element in the judgment is, of course, the relation of subject and predicate, the principle according to which propositions are divided into categorical, hypothetical and disjunctive. We have seen that a term considered in itself is merely a possible subject or predicate, that in fact each part of a proposition, subject, predicate or copula, takes its character from the other two. We have now to point out the differences that arise on account of the peculiar ways in which a predicate is asserted or denied

of a subject. The expression of a judgment will naturally reveal every phase of the mind's act and consequently will state not merely the fact of a relation but the manner of it; will state, for instance, not merely *that a* quality belongs to a thing but *how* it belongs to it, whether necessarily, accidentally, conditionally or as an alternative. It is the relation of subject and predicate in this sense that serves as a basis for the division under consideration; accordingly, 1, when the relation is unconditional—S is P—the proposition is categorical; 2, when the relation is conditional—if S is A, it is P—the proposition is hypothetical; and 3, when the relation is offered as an alternative—A or B is P; S is A or B—the proposition is disjunctive. These three kinds of propositions we shall consider more particularly in separate chapters.

QUESTIONS AND EXERCISES

1. What is the quality of a proposition?
2. Discuss the difficulty of determining the quality of such propositions as (a) "Every politician is not a statesman" and (b) "A viper cannot run."
3. Does (a) illustrate the statement that the form is conditioned by the matter?
4. What is the quantity of a proposition?
5. What is a universal proposition? What are its subclasses?
6. Name some of the signs that indicate a distributed use of the subject. Explain the twofold function of "no."
7. Distinguish between general propositions that are enumerative and those that are expository. Should they be expressed differently?
8. On what condition may a general proposition become particular? Illustrate.
9. Why may singular propositions be regarded as universal?

10. How should a universal proposition whose subject is a collective term be classified?

11. What is a particular proposition?

12. Name some of the signs that indicate an undistributed subject.

13. Explain the logical use of "some." May other signs of particular quantity have the same use? Illustrate.

14. What are partitive propositions?

15. Give partitive propositions beginning with "some," "most," "not-all," "a few," "few," and then give the propositions of opposite quality which are implied.

16. Explain the statement that Exceptive Propositions assert in an affirmative way a rule and its exception.

17. Treat an exceptive proposition by resolving it into (a) two particulars and (b) two universals.

18. Explain the statement that Exclusive Propositions assert in a negative way a rule and its exception.

19. In what two ways may exclusive propositions be treated?

20. Give the reason why the predicate of an exclusive proposition is always distributed.

21. Show how a subject may be quantified not by the usual signs of quantity but by other modifying words, phrases, or clauses.

22. Discuss the ambiguity in the proposition, "All the students who live on the campus are industrious."

23. What are "indesignate" propositions? How should they be treated?

24. What is the quantity of "moral" universals?

25. Explain the use of the symbols A, E, I, O?

26. How are the subject and predicate related in categorical propositions? In hypothetical? In disjunctive?

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CHAPTER XIII

CATEGORICAL PROPOSITIONS

DEFINITION. A categorical proposition is one in which the affirmation or denial is made without limitation. It is symbolized in the forms S is P, S is not P. The examples we have heretofore used for the sake of illustration have been of this sort.

THE LOGICAL STRUCTURE OF A CATEGORICAL PROPOSITION

Ordinarily a proposition should not be employed for logical purposes unless its subject, copula, and predicate are set forth separately in the order named. As a rule these elements are easily isolated, but it may be well to note some of the difficulties that are met with in making grammatical statements conform to the logical type.

THE SUBJECT is the term upon which the assertion or denial falls, and it can always be discovered by asking who or what is spoken of. There are two cases in which the subject may occasionally seem hard to identify; first, when there is inversion, as for example, "A prophet is he" instead of "He is a prophet;" and second, when a clause modifying the subject is placed near the predicate, as for example, "All are saved who prayed" instead of "All who prayed are saved."

So-called "impersonal" subjects have no place in a logical proposition. Statements in which they occur, however, can easily be rearranged in such a way as to lay bare the real subjects. For instance, the sentences "It rains," "It's blowing," and "There grows an oak beside the brook," may with little trouble be transformed into "Rain is falling," "The wind is blowing," and "An oak is growing beside the brook."

THE COPULA should always be rendered in the present tense. The reason for this is because the judgment invariably reveals a relation which here and now exists and which is therefore a present mental fact. Hence such statements as "Some of the lieutenants will be captains," "All the houses were burned" should be changed to "Some of the lieutenants are officers who will be captains," and "All the houses are structures that were burned."

Perhaps it would not be amiss to repeat here the caution against regarding as negative the copula in such a proposition as, "All soldiers are not brave."

THE PREDICATE. It frequently happens that the grammatical predicate conceals both the logical predicate and the copula, as in the sentence "Dogs bark," the logical structure of which is "Dogs are animals that bark." It is easy to analyze the grammatical predicate into the logical predicate and copula unless the verb is modified by the particle "not." In such case it is always a question whether the logical proposition should be affirmative or negative. For instance, if the given sentence is "He does not see the light," the logical resultant may be either, "He is a person who does not see the light" or "He is not a person who sees the light."

NECESSARY AND CONTINGENT RELATIONS. The relation of subject and predicate may be *necessary* or *contingent*: it is necessary when it cannot be other than it is; contingent when it might be other than it is. This distinction gives rise to the division of categorical propositions into (1) Analytic and (2) Synthetic.

1. *Analytic Propositions are those in which the terms* MUST *be affirmed or denied of each other, in which therefore* (*A*) *the notion of the subject involves* (*or excludes*) *the predicate or* (*B*) *the notion of the predicate involves* (*or excludes*) *the subject.*

A. The subject is said to involve the predicate when the latter sets forth the whole or a part of the essence and is therefore a species, a differentia, or a genus. In such case the subject carries in its content all that is expressed in the predicate. Definitions afford good examples of this sort of analytic proposition. Also the laws of thought as well as the axiomatic truths employed in the various sciences are analytic in this sense.

B. The intension of a general subject term embraces no more than the essential characteristics of a class; hence if the predicate denotes a non-essential characteristic and the relation between the terms is nevertheless necessary, the proposition is analytic on the ground that the intension of the predicate involves the subject. This is the case only when the predicate is a property, for the distinguishing note of a property is that it pertains to a given subject in such a way that where it is the subject is and where it is not the subject cannot be. From this point of view the statement, "Man is a being that cooks" is an analytic proposition, because although the predi-

cate is no part of the content of "man," the function of "cooking" is necessarily connected with human nature.

Some logicians restrict the application of the term analytic to propositions which meet the requirements included under (A).

2. *Synthetic Propositions are those in which the relation of subject and predicate is not involved in the intension of either.* The predicate of such propositions, therefore, is always an accident and its connection with or exclusion from the subject is a matter of experience. For instance, that a man is prudent, tall, handsome, walking, stooped, pale, hurt, or well-dressed are items that might be asserted or denied of him depending on observation.

Analytic and synthetic judgments are the same respectively as judgments *a priori* and *a posteriori*. Knowledge derived from a study of the cause is called *a priori* whereas knowledge that originates in an observation of the effect is called *a posteriori*. The Latin terms indicate the source of our certitude, for cause is prior in nature while effect comes last. In an analytic judgment our understanding of the subject, case (a), or of the predicate, case (b), is the cause or reason for the necessary truth which is asserted; hence the proposition is *a priori*. In a synthetic judgment the predicate is not a mere unfolding of the nature of the subject but is seen to belong to it on evidence drawn from observation; hence the proposition is *a posteriori*.

MODALITY IN PROPOSITIONS. The question of modality, based not only on the fact but also the manner of the relation between the subject and predicate, has been partially treated in

pointing out the difference between analytic and synthetic propositions. It remains merely to note that sometimes the manner of the relation receives expression in the copula; when this is the case the proposition is called *modal* otherwise it is said to be *pure*. A proposition will still retain its character as analytic or synthetic even when it is modal.

The modes of relation are, as we have said, two in number—necessary and contingent; but the necessary mode presents a double aspect depending on whether the predicate *must be ascerted* or *must be denied of the subject*. Hence it is usual to speak of three modes: first, the necessary, as for example, "A man must be rational" or, "A man cannot help being rational;" second, the impossible, as for example, "No effect can be more perfect than its cause;" and third, the contingent or possible, as for example, "Some rainy days may be pleasant," or "A loose wheel was the probable cause of the accident."

SUBJECT AND PREDICATE IN EXTENSION: EULER'S CIRCLES. When two concepts are related as subject and predicate it is sometimes their intension and at other times their extension that is uppermost in the mind, and yet account must be taken of both phases in every act of judgment. We have seen in our discussion of definition and division that meaning and application reveal each other, that to define a term is also to restrict its application and to divide a term is to show forth its power of entering into specific meanings. And since intension and extension thus throw light upon each other it would seem possible to gain some knowledge of the one by ascertaining certain facts about the other. This is the point of view of those logicians who employ "Euler's Circles" to show

how subject and predicate are related in their extension. The circles help the imagination to fix the limits of inclusion or exclusion; and while they do this directly, they indirectly furnish information about the content of the terms compared; for inclusion always implies agreement, and exclusion disagreement in meaning. To declare for instance, that all roses lie within the class "flowers" is to bring out the point that the individuals denoted by the subject carry the same meaning—that each of them may take two names, "rose" and "flower"; and on the other hand to declare that no roses lie within the class "lilies" is to bring out the point that the characteristics of the one group are not the same as those of the other.

With the understanding, then, that graphic representations of the way in which subject and predicate are related in extension are to be conceived as indirectly showing how they are related in intension, we may proceed to give the diagrams which were first used by the logician whose name they bear.

DIAGRAMS OF EXTENSION

I. UNIVERSAL AFFIRMATIVE OR A PROPOSITIONS. The extension of subject and predicate in A propositions is represented in two ways depending upon whether the predicate is distributed or not.

1. When the predicate is undistributed, as in the proposition, "All druggists are chemists," the whole of the subject lies within but does not exhaust the predicate. An A proposition of this kind is said to be Typical. A circle P circumscribing a circle S will stand for the difference in extension, thus:

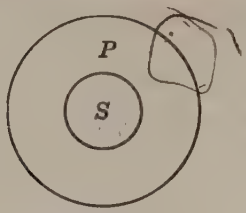

Fig. I.

2. When the predicate is either a singular term, a definition, or a property its extension of course, equals that of the subject. All A propositions of this kind are conveniently described as Atypical: those that have singular predicates are also called Identical. None of these cases can be adequately represented by circles because both terms have the same application. Hence to keep in mind the relation of extension in such propositions as "All equiangular triangles are equilateral" and "Smith is the manager," we must imagine two circles with equal diameters placed one upon the other, as in Fig. II.

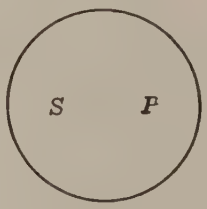

Fig. II.

II. UNIVERSAL NEGATIVE OR E PROPOSITIONS. In E propositions such as "No plants are animals," the subject and predicate are mutually exclusive; consequently their representative circles must stand apart as in Fig. III.

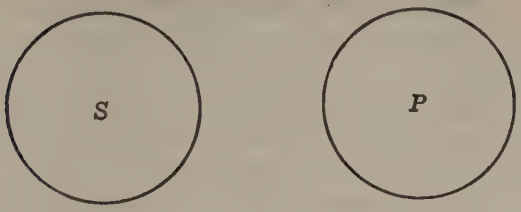

Fig. III.

III. PARTICULAR AFFIRMATIVE OR I PROPOSITIONS. In the case of I propositions the diagram must show the partial extension of the subject. Fig. IV meets this requirement.

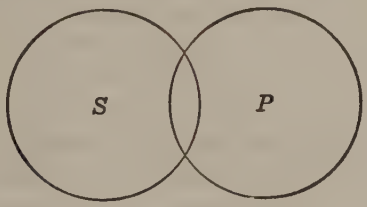

Fig. IV.

Fig. IV, however, has the following limitations:

1. It adequately represents the relation of subject and predicate in such propositions as "Some of the apples are ripe," though even in this instance it does not provide for the possibility of all the apples being ripe. Hence if "some" is employed in the logical sense of "one or more, perhaps all," Fig. I as well as Fig. IV must be taken to cover the indeterminable distribution of the subject.

2. In Fig. IV inclusion is limited not only to part of S but also to part of P. Yet in a good many I propositions the predicate is always distributed. For instance, it is always distributed (a) in propositions

that set forth the relation of genus to species if the former is used as subject, as, "Some men are Caucasians," and (b) in exclusive propositions which although they do not distribute the subject, carry the predicate in its full extension, as "Only (some: one or more, perhaps all) Africans are black." I propositions with a distributed predicate must be diagramed as in Fig. V in which the inclusion is restricted to the portion of S that lies within P.

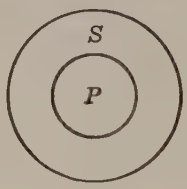

Fig. V.

3. Partitive propositions show a relation of subject and predicate which may be illustrated by either Fig. IV or Fig. V but not by Figs. I and II. Fig. IV should be used to diagram such propsitions as "Some lawyers are honest" in which the subject is paired by dichotomy but in which the predicate is undistributed. An exceptive proposition, when its complementary pairs are not universalized, is treated like any other partitive.

IV. PARTICULAR NEGATIVE OR O PROPOSITIONS. No new arangement of circles is necessary to represent the relation of terms in O propositions, only in applying particular cases of O to the foregoing figures we must reverse our picture so as to imagine exclusion instead of inclusion. Of course in O propositions some of the predicate may and in certain in-

stances must be included in part of the subject, but *always* the whole of the predicate has to be excluded from the subject as quantified.

The following examples will illustrate the ways in which O propositions may be applied to the diagrams:

(1) When the sign of quantity is "some" in the logical sense, as in the proposition, "Some (one or more perhaps all) of the apples are not ripe," Fig. IV will represent the relation in so far as the subject is definitely particular, and Fig. III in so far as it is possibly universal.

(2) Partitive propositions are diagrammed as in Fig. IV when the class represented by the predicate shows at least some individuals that are not included within the complete extension of the subject, as for example, "Some birds are not web-footed." Fig. V, however, must be used to show the relation of subject and predicate of partitive propositions when all of the predicate falls within the extension of the subject, as for example, "Some Europeans are not Italians," in which case those members of S which are within the circle P are Italians while the other members of S are not Italians.

DISTRIBUTION OF SUBJECT AND PREDICATE. It might seem unnecessary following the discussion of the relation of subject and predicate in their extension to refer again to the question of quantity; but in view of the fact that from now on a large part of our study will be devoted to logical forms, it may be advisable to give a final admonition as to how the application of terms should be handled when their matter, or meaning, is left out of consideration. The points to be remembered may be set down as follows:

A Subject distributed, predicate unidistributed.
E Subject distributed, predicate distributed.
I Subject undistributed, predicate undistributed.
O Subject undistributed, predicate distributed.

QUESTIONS AND EXERCISES

1. How should categorical propositions be symbolized?
2. Is it important to insist on the logical as distinguished from the grammatical structure of a proposition?
3. What difficulties may be encountered in finding the subject of a proposition?
4. Why should the copula always be expressed in the present tense?
5. If in a grammatically negative proposition the grammatical predicate conceals both the logical predicate and the copula, will the resultant logical proposition be affirmative or negative?
6. What is the difference between a necessary and a contingent relation of subject and predicate? To what division of categorical propositions does this difference give rise?
7. Explain the statement that in analytic propositions either the notion of the subject involves (or excludes) the predicate or the notion of the predicate involves (or excludes), the subject. Give examples.
8. What is the character of the predicate in synthetic propositions.
9. When is a proposition said to be "model." Illustrate.
10. What is the direct purpose of employing Euler's Circles? What is indirectly revealed by them?
11. Give the reason for using two methods of representing by Euler's Circles the relation of subject and predicate in A propositions.
12. When the subject is a genus and the predicate a species what is the type of proposition and how should the relation of its terms be represented by Euler's Circles?
13. What are the two methods of representing the relation of subject and predicate in partitive propositions?
14. Explain the three ways of representing the relation of subject and predicate in O propositions.
15. Say whether the following propositions are analytic or synthetic. Give a reason for your answer in every case.

(1) A straight line is the shortest distance between two points.
(2) Matter is ponderable.
(3) Zebras are striped.
(4) All the battle-ships are painted gray.
(5) Animals are organisms.
(6) Houses have walls.
(7) Swans are white.
(8) A man is a being that laughs.
(9) Glue sticks.
(10) American women are tall.
(11) A circle is not a three-sided figure.

16. Put the following propositions in logical form. State the logical type (A, E, I, O), and represent the relation of subject and predicate by means of the circles.

(1) There is honor among thieves.
(2) Some of the food will last.
(3) Monte Christo said, "The world is mine."
(4) It is pouring rain.
(5) He was left behind.
(6) A merry old soul was he.
(7) The man is lost who refuses to help himself.
(8) Kings have been false to their trust.
(9) Only unselfish persons have kind hearts.
(10) Few men attain to greatness.
(11) All but the strongest perished.
(12) None were admitted but those who had tickets.
(13) Lincoln was the Great Emancipator.
(14) Some of the trees will not be trimmed.
(15) Few soldiers have the title of general.
(16) Every reporter cannot write well.
(17) Heads I win.
(18) You were elected chairman.

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CHAPTER XIV

IMMEDIATE INFERENCE: OPPOSITION

INSTEAD of proceeding to a discussion of hypothetical and disjunctive propositions we may now enter the field of Logic proper and introduce some of the problems of inference. The purpose of our study of terms and propositions was to become familiar with the ways in which truth is set forth. Without a knowledge of the literal meaning and express application of judgments we could hardly expect to discover what is involved in them. Consequently we have devoted considerable attention to the more obvious means of interpreting thought. In this and the following chapter we shall be engaged in examining certain conditions and processes which lead to the unfolding of truth.

INFERENCE. *Inference is a process of acquiring truth without seeking fresh objective evidence either from sense experience or authority.* Judgments conceal more than they directly reveal and imply more than they express, and inference brings out their fuller meaning. Through inference the mind builds truth upon truth, unfolds a new judgment from the elements of an expressed relation. In its simplest form it is the act of disclosing what lies hidden in a statement and announcing the disclosure in another statement; it is a rendering explicit of what is implicit in a given thought; it is, therefore, a pressing forward

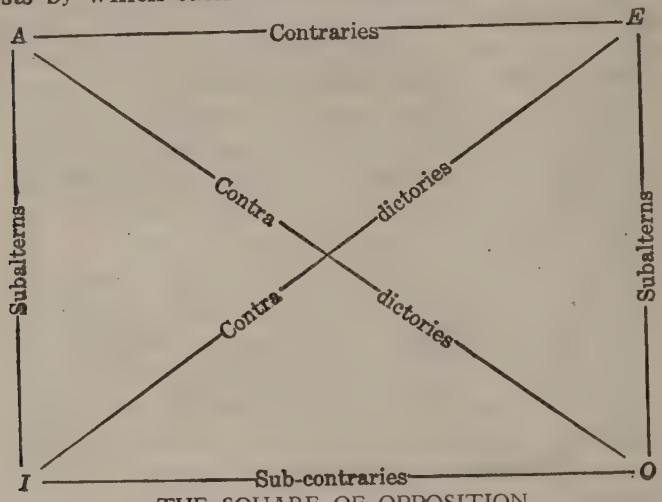
from one truth to another basing the advance on nothing else than the material furnished at the starting point. Sometimes this material is complex involving two or even more judgments and then the advance to a new truth is usually called *reasoning* or *mediate inference;* sometimes, on the other hand, it is simple, consisting of only one judgment and in this case the advance to a new truth is called *immediate inference.* "Inference" is therefore a generic term including "reasoning" as one of its species; this distinction, however, is not always observed, and the two names are often employed synonymously.

FORMS OF IMMEDIATE INFERENCE. In general there are two forms of immediate inference—Opposition and Eduction. There is this difference between them: in Opposition we advance to new truths from certain relations which are limited by the fact that the subjects and predicates of the inferred propositions are exactly the same as the corresponding original terms; whereas, in Eduction this condition is removed and a change of matter always occurs. The processes commonly grouped under the heading of Eduction are Obversion, Conversion, Contraposition, Inversion, Antithesis, Added Determinants, and Converse Relations.

OPPOSITION OF PROPOSITIONS. Propositions which have the same subject and predicate but which differ in quantity or quality or both are said to be "opposed." The so-called "Square of Opposition" (see next page) reveals all the relations that are possible under the conditions.

When the structure and meaning of this diagram is understood it should not be difficult to see that given the truth or falsity of any proposition on the

"square," the truth, or falsity or doubtful character of all the others is involved. We shall first explain the four kinds of opposition and then summarize the tests by which each of the relations is established.



THE SQUARE OF OPPOSITION

1. A—E. CONTRARIES. The universal affirmative and negative represent "sweeping denials" of each other and consequently express the extremes of thought about a subject and its predicate. The truth, however, may lie between the extremes, that is, contraries do not exclude a middle. Thus between the extremes "All men are prudent" (A) and "No men are prudent" (E) experience compels us to insert as true the two mean propositions, "Some men are prudent" (I) and "Some men are not prudent" (O). Contraries may both be false but cannot both be true.

2. A—O; E—I. CONTRADICTORIES. The universal affirmative and the particular negative, the universal negative and the particular affirmative represent

simple denials of each other; consequently between each of these pairs there is no other thought possible about a subject and its predicate. The truth lies in one or the other, for they differ not only in quantity but also in quality. A simple denial of a universal may be made by pointing out one exception, as for example, "All politicians are selfish" (A), "Some (one at least) are not selfish" (O); whereas a simple denial of a particular can be made only by establishing the opposite universal; for example, to contradict the statement "Some dirigibles are safe," (I) one should have to prove "No dirigibles are safe" (E). The task of contradicting a particular, therefore, is not easy. Since contradictories are not "sweeping denials" they rest directly on the principle of excluded middle. Hence they cannot both be false or true, but if one is true the other must be false, and vice versa.

3. A—I; E—O. SUBALTERNS. The use of the word "subalterns" seems to imply that if any affirmation of the subject is to be made the proposition must be either A or I; and if any negation is to be made the proposition must be either E or O. In this relation A and E are called subalternants and I and O subalternates. The truth of the universals implies the truth of the particulars, but the truth of the particulars leaves the universals doubtful. On the other hand if a subalternant is false its subalternate is doubtful, whereas if a subalternate is false its subalternant is also false. Hence each pair of subalterns may be false or true together.

4. I—O. SUB-CONTRARIES. The name of this relation is doubtless taken from the position of the particulars on the "square," that is, subordinated to the contraries. At all events they are in no sense

denials of each other; they do not resemble contraries at all and resemble contradictories only in this, that one of them must be true. Partitive propositions afford good examples of this opposition. Sub-contraries may both be true but cannot both be false.

TESTS

1. A—E. CONTRARIES. If one is true, the other is false; if one is false the other is doubtful; or both cannot be true but both may be false.

2. A—O; E—I. CONTRADICTORIES. If one is true the other must be false, and vice versa; or both cannot be true and both cannot be false.

3. A—I; E—O. SUBALTERNS. If the subalternant is true, the subalternate is true, if the subalternant is false, the subalternate is doubtful; if the subalternate is true, the subalternant is doubtful, if the subalternate is false the subalternant is false. Or both may be true or both may be false.

4. I—O. SUB-CONTRARIES. If one is true the other may be true or false. If one is false the other must be true. Or both may be true, both cannot be false.

Applying the tests we have the following results:

If A is true, I true, E false, O false.
If E is true, O true, A false, I false.
If I is true, A possible, O possible, E false.
If O is true, E possible, I possible, A false.
If A is false, I possible, E possible, O true.
If E is false, O possible, A possible, I true.
If I is false, A false, E true, O true.
If O is false, E false, A true, I true.

Singular Propositions in Opposition. Attention should be called to the fact that since singular prop-

ositions are universal in quantity they are always either A or E; nevertheless strictly speaking they are not contraries but contradictories, because it is impossible for both to be true or false at the same time.

MATERIAL OPPOSITION. It will be useful to remember that certain pairs of propositions which do not have the same subjects and predicates may be so related in matter as to exhibit some of the forms of opposition. For instance, when both subjects or both predicates are related as genus and species, the propositions are opposed as subalterns; when both predicates are related as coördinate species, the propositions will be contraries, if not contradictories. Let us see some cases in point.

1. The same subjects with one predicate a genus and the other a species; for example, "All the team are Americans" and "All the team are Kentuckians." Both propositions are universal (A) and they are obviously subalterns. That "All the team are Kentuckians" implies that "All the team are Americans." The rule in such cases is: the predicate that is the species renders its proposition the subalternant; whereas the predicate that is the genus renders its proposition the subalternate.

2. The same predicates with one subject a complete genus, the other a complete species; for example, "No physicians are illiterate" and "No surgeons are illiterate." Here both propositions are universals (E) and are clearly subalterns. The fact that "No physicians are illiterate" implies that "No surgeons are illiterate." The rule in this case is: the subject that is the genus renders its proposition the subalternant; whereas the subject that is the species renders its proposition the subalternate.

3. The same subjects with the predicates coördinate species; for example, "Brown is a Virginian" and "Brown is a Kentuckian." In this case although both propositions are universal affirmatives (A) they are evidently contraries for both cannot be true and both may be false. The rule in such cases is: when the predicates are coördinate species the propositions are *contraries,* if there are more than two species; and *contradictories* if there are only two species. Thus, "Brown is a native of the New World," "Brown is a native of the Old World" would be contradictories.

It may added that there is sometimes material opposition even when the terms are not genera or species: as for example, "All immigrants are rich," (A) "All immigrants are poor" (A). Here the predicates, which are contrary terms, render the pair of universal affirmatives contraries.

QUESTIONS AND EXERCISES

1. What is inference?
2. Should the terms "reasoning" and "inference" be used interchangeably?
3. Distinguish between immediate and mediate inference.
4. What is the difference between Opposition and Eduction?
5. Construct the Square of Opposition.
6. Give the test of contraries, contradictories, sub-contraries, and subalterns.
7. Why is the opposition of singular propositions contradictory?
8. Suppose it is false that "Some books are not vulgar," what may be said of the truth or falsity of the three "opposite" propositions?
9. Give the contrary (or sub-contrary) and the contradictory of the following propositions:

(1) All the rivers in the United States do not flow south.
(2) Wood is inflammable.
(3) No sluggards climb very high.
(4) Most physicians are humane.
(5) Some beggars are probably not in need of help.
(6) Only the industrious can be content.
(7) None of those were present today who were absent yesterday.
(8) Every sin is not mortal.
(9) None but those shall be rejected who have not cleansed their heart.
(10) Some buildings are not structures that will last.

10. Give the subalternate or the subalternant of each of the foregoing propositions.

11. What relation of opposition obtains between the following pairs of propositions?

(1) "All Frenchmen are volatile" and "All Parisians are volatile."
(2) "All the laborers were Italians" and "All the laborers were Neapolitans."
(3) "This bird is a robin" and "This bird is a meadow lark."
(4) "This animal is a vertebrate" and "This animal is an invertebrate."
(5) "All the members are wise" and "All the members are foolish."

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CHAPTER XV

IMMEDIATE INFERENCE: EDUCTION

EDUCTION is immediate inference in which the mind acquires a new truth in virtue of seeing what is implied when a given proposition undergoes a change of subject or predicate or both. The "new" matter of the educed proposition has its character defined by the processes involved, namely, the substitution of one term for the other, or the use of the simple negative of a term for the term itself. The use of the simple negative of a term instead of the term itself is justified by the Law of Contradiction according to which if a thing is A the possibility of its being non-A must be denied. In the various forms of eduction, therefore, supposing the original proposition to be an affirmation or denial about *S* and *P*, we may meet with the "new" material *Non-S* and *Non-P*.

I. OBVERSION

Obversion is a process of eduction in which the mind after comparing the subject of a given proposition with the contradictory of its predicate perceives the new relation as opposite in quality. The given proposition is called the *obvertend*, the resultant the *obverse*. The obverse should be constructed according to the following rule: *Retain the subject, contradict the predicate, and negate the copula.* All the

four types of propositions lend themselves to this form of eduction, and owing to the change of quality, A is obverted to E, E to A, I to O, O to I.

The obversion of affirmative propositions is based upon the Law of Contradiction; for if it is true that S is P it is also true that S cannot be non-P.

The obversion of negative propositions is based upon the Law of Excluded Middle, according to which S is either P or non-P; that S is P, however, is false since the accepted obvertend is negative; therefore, it must be true that S is non-P. Obversion of the four types of propositions may be illustrated as follows:

1. Obvertend: A All snails are mollusks.
   Obverse: E No snails are non-mollusks.

Here the mind in the act of conceiving "non-mollusks" necessarily excludes "snails" which are included in "mollusks."

2. Obvertend: E No aliens are voters.
   Obverse: A All aliens are non-voters.

In this case it is easy to see that if there is no "alien" within the class "voters," "all aliens are non-voters."

3. Obvertend: I Some heat is enervating.
   Obverse: O Some heat is not non-enervating.

On the principle of Contradiction, since "some heat" is said to be "enervating" it cannot be "non-enervating."

4. Obvertend: O Some meetings are not profitable.
   Obverse: I Some meetings are non-profitable.

According to the Law of Excluded Middle "Some meetings" must be either "profitable" or "non-profitable"; the obvertend states the accepted truth that it is not "profitable," therefore it must be "non-profitable."

In performing obversion the confusion of nego-positive terms with simple negatives should be avoided; for instance, "impious," "immoral," "foolish" may not be substituted as the contradictories of "pious," "moral," "wise."

The process of obversion seems to be involved whenever a proposition in which the verb is modified by the particle "not" is put into logical form. For this reason some logicians contend that obversion is not inference at all and that any two propositions of which one is the obverse of the other are merely the positive and negative ways of expressing the same truth. Thus, the proposition "He does not read," may be reduced to "He is a man that does not read," or to "He is not a man that reads." Without going any further into the discussion it may be pointed out that depending upon whether a positive term or its contradictory is employed, both the picture in the imagination and the meaning in the intellect will be different; consequently, once a term is used in a given proposition its contradictory cannot be compared with the subject unless there arise a new picture in the imagination and a new meaning in the intellect—a change which appears to furnish basis enough for the contention of those who say that obversion is a process of inference. At all events there is no warrant for the point of view which regards obversion as a mere verbal change, a mere juggling with the particle "not."

II. CONVERSION

Conversion is a process of eduction in which the mind, seeing that the perceived relation of a given judgment will support an interchange of terms, ex-

presses the new truth in a proposition whose subject is the given predicate and whose predicate is the given subject. For example, "No patriots are cowards" is converted into "No cowards are patriots." The original proposition is called the *convertend,* the resultant the *converse.*

Since the relation of terms in the converse is, as it were, a backward view of their relation in the convertend the quality of both propositions is the same. Whether the quantity of both is the same or not depends upon the extension of the original predicate; unless it is distributed, the converse must be particular.

RULE FOR CONVERSION. The converse should be constructed according to the following rule: *Transpose the original subject and predicate; make no change in quality; do not distribute an undistributed term.*

JUSTIFICATION OF THE PROCESS. Conversion receives its justification from the very nature of predication, which is concerned not merely with meanings, but also with their application. Of course every assertion or denial announces that a subject has or has not a quality or group of qualities; to say for instance that a man is a lawyer is to state that he possesses, besides human nature and obvious individual characteristics, the mental equipment that fits him for the practice of law. But in addition to this attributive interpretation of predication there is its interpretation with reference to extension; and it is the latter which prevails when the mind acquires a new truth by means of conversion. Every assertion or denial states in effect that a subject is or is not a *thing* which possesses a quality or group of qualities. In affirmative propositions the force of the judgment is to iden-

tify the subject as an object in which the predicate-attribute is concreted; to say, for instance, that "Some collars are white" is to announce that "some collars" and "certain white things" are the same objective realities; and since they are the same, the truth will receive exact expression in the converse, "Some white things are collars." In negative propositions the judgment has the force of excluding the subject from the whole class of *things* in which the predicate-attribute is concreted; and if the subject is taken in its fullest extension, that is, if the exclusion is mutual, there is warrant for the process of conversion. Thus, from "No wise men are mean" we may pass to "No mean persons are wise."

KINDS OF CONVERSION. If as we have just noted a proposition becomes available for conversion only when its matter is interpreted in extension, it follows that the freedom with which the process can be performed will be restricted by considerations of the distribution of terms. Such considerations prevent altogether the conversion of O propositions, limit the conversion of A propositions to I, and provide for the inference from E and I propositions without a change of quantity. The process of passing from A to I is called conversion *per accidens* or *by limitation*. On the other hand, the process of educing E and I from propositions of the same quantity is called *simple conversion*. It will be found that the manner of formally converting the three types of propositions capable of undergoing this process may be verified by a study of the relations of subject and predicate as represented in Euler's circles. With these diagrams in mind let us review the various cases.

CONVERSION OF A PROPOSITIONS. The formal conversion of the universal affirmative is limited to the particular affirmative because the predicate in the convertend is undistributed and cannot be distributed as the subject in the converse. In the typical A, the extension of the predicate is wider than that of the subject; consequently only some of the predicate can be thought of as identical with the class denoted by the subject. Thus, granted that "All chisels are tools" it would follow by conversion that "Some tools are chisels"; to conclude that "All tools are chisels" would be to violate the rule which forbids the distribution of an undistributed term.

The *simple* conversion of A is possible in exceptional cases; when the proposition is Identical or when the predicate is known to be a definition, or a property, both terms are of course distributed and no law of thought is violated in performing a simple conversion. Thus, from "All spirits think" we may pass to "All beings that think are spirits." The point to remember, however, is that the right to make such an inference cannot issue from the *form* of the convertend.

Mistakes in conversion are often due to negligence in reducing a given proposition to logical form. Attempts like the following are all too common; from "The poor are to be pitied who cannot help themselves" to "The pitied who cannot help themselves are the poor"; from "John struck James" to "James struck John"; from "Blessed are the meek" to "The meek are blessed." Errors of this sort could hardly occur if the convertends were first set forth with their elements, subject, copula and predicate, in proper order. The correct conversions in the foregoing in-

stances would be: "Some persons that are to be pitied are the poor who cannot help themselves," "A (or the) person who struck James is John," and "Some persons who are blessed are meek."

CONVERSION OF E PROPOSITIONS. E is converted simply—from SeP to PeS. For example, from the convertend, "No country is prosperous while at war" (logical form: "No country that is at war is a prosperous nation") we may infer "No prosperous nation is a country that is at war." A reference to the representation of E propositions in the Euler diagrams will bring out the fact that both subject and predicate in the convertend are distributed; and the truth of their mutual exclusion when transposed could not be unfolded unless they were distributed in the converse.

CONVERSION OF I PROPOSITIONS. I propositions are converted simply—from SiP to PiS. For example, from "Some lyrics are sentimental" we may conclude "Some sentimental poems are lyrics." In this case it will be seen that since the original subject is undistributed because the proposition is particular, and the original predicate is undistributed because the proposition is affirmative, a conversion to A would be impossible without distributing an undistributed term, and a conversion to E would be impossible without a change of quality.

The conversion of I to A is possible, however, in some instances. A glance at Euler's circles will show that these exceptions are provided for in Fig. V. Exclusive propositions, for example, are known to take a distributed predicate; and although they are always I propositions, it would be idle to convert them without retaining the distribution of the predicate term

when it is employed as subject in the converse. Hence we should invariably convert an exclusive proposition into the A type; thus from "Only citizens vote" we should educe "All who vote are citizens." Again, any I proposition whose predicate is known to be a property or a species and therefore distributed should be converted into an A; for instance, to avoid an absurd implication "Some men are lawyers" should have as its converse "All lawyers are men."

CONVERSION OF O PROPOSITIONS. A proposition which in its logical form is manifestly an O cannot be converted. On the supposition that conversion of this type were possible the converse would by the rule of quality be negative because the convertend is negative; but negative propositions have the predicate distributed, hence the predicate of the converse would be distributed. Since, however, this term is the original subject, undistributed in the convertend, an attempted conversion would clearly violate the rule which prohibits any increase in the extension of the given matter.

Sometimes a proposition of the verb-predicate type, although apparently a particular negative, may on being reduced to logical form stand out as a particular affirmative. Thus, "Some animals do not crawl" might be called an O proposition; as a matter of fact it is not in logical shape and should receive no logical classification. It may be resolved into "Some animals are creatures that do not crawl" (I), or "Some animals are not creatures that crawl" (O). As reduced to the first logical form it may of course be converted into "Some creatures that do no crawl are animals."

The next two forms of eduction involve no new processes; the final inference aimed at in each case is

merely the result of employing obversion and conversion in a certain order and to a certain extent. In other words, Contraposition and Inversion amount to nothing more than an application of the two foregoing types of immediate inference.

III. CONTRAPOSITION

Contraposition is a process of eduction in which the mind after obverting a given proposition perceives a converse relation between the new subject and predicate and expresses this acquired knowledge in a proposition whose subject is the contradictory of the given predicate. For example, the O proposition, "Some old manuscripts are not legible," implies the obverse I, "Some old manuscripts are illegible," which in turn implies the converse I, "Some illegible writings are old manuscripts"—and this resultant is called the contrapositive.

The rule for contraposition is: *Convert the obverse of the given proposition.*

I is the only one of the four logical types that cannot be contraposited. This is so because the obversion of an I leads to an O, the conversion of which has been shown to be impossible.

A distinction of minor importance is sometimes made between the *partial* and the *full* contrapositive. The former is the twofold inference which has been referred to in the foregoing example as simply the contrapositive; the latter is reached by carrying the inference a step further by means of another obversion. The full contrapositive of our original would be "Some illegible writings are not manuscripts that are not old."

The purpose of educing as far as the full contra-

positive is to acquire a new truth that has the same quality as the given proposition.

IV. INVERSION

Inversion is a process of eduction in which the mind beginning with either obversion or conversion of a given proposition pursues an alternating succession of these inferences until it arrives at a judgment whose subject is the contradictory of the given subject. The original proposition is called the Invertend, the resultant the Inverse.

This method of eduction has little practical value except to test the student's acquaintance with the forms already considered. Each of the logical types should be experimented with according to the following general directions: first, let us say, obvert the original, then continue with conversion and obversion alternately until either the inverse is obtained or further inference becomes impossible; if the method of employing obversion first does not succeed, try conversion first and carry on with obversion and conversion alternately as before.

Experiments conducted after this fashion will show that A cannot be inverted unless it is first obverted, that E cannot be inverted unless it is first converted, and that I and O cannot be inverted at all. In addition to the general directions, therefore, these special rules may be offered: *To invert A obvert first; to invert E convert first.*

An example will show the manner of inverting A:

Original:	A	All negroes are black.
Obverse:	E	No negroes are non-black.
Converse:	E	No non-black men are negroes.
Obverse:	A	All non-black men are non-negroes.
Converse:	I	Some non-negroes are non-black. **Inverse.**

An example of the inversion of E:

Original:	E	No Democrats are Republicans.
Converse:	E	No Republicans are Democrats.
Obverse:	A	All Republicans are non-Democrats.
Converse:	I	Some non-Democrats are Republicans. Inverse.

A distinction of little practical value is sometimes made between the *partial* and the *full* inverse. The only purpose of the distinction is to have the predicate of the full inverse uniform in structure; that is, to make it invariably the contradictory of the original predicate. In the foregoing examples it will be seen that what was called the inverse of A is the *full* inverse, whereas what was called the inverse of E is the *partial* inverse; and in general when A is inverted the full inverse is obtained first, and when E is inverted the partial inverse is obtained first. Consequently an added process of obversion will yield in the A series the partial and in the E series the full inverse. In our examples, the partial inverse of A is O, "Some non-negroes are not black;" and the full inverse of E is O, "Some non-Democrats are not non-Republicans."

ANTITHESIS. The antithesis of a proposition consists of the contradictory of its subject and the negative of its copula with no change of quantity. This process can be applied to none but affirmative propositions and to these only on condition that they have a distributed predicate—a condition that is never fulfilled except in the exclusive I and in the atypical A. Although antithesis has the appearance of a separate form of immediate inference, it should be classified as a special kind of Inversion. Thus if we invert "All Caucasions are white" by beginning with simple con-

version, we reach the antithesis "No non-Caucasians are white."

Rhetorical antithesis is commonly employed as an aid to beauty and force. It is to be met with frequently in the Scriptures. The following example is from the Book of Proverbs XI. 1: "A deceitful balance is an abomination before the Lord: and a just weight is His will." In this passage the Wise Man in righteous zeal for his cause asserts that a deceitful balance is the one thing the Lord hates; consequently a non-deceitful balance (a just weight) invariably meets His approval.

SUPPLEMENTARY EDUCTIONS

We may next consider certain forms of immediate inference which derive their validity from the matter they involve.

1. EDUCTION BY ADDED DETERMINANTS. In this kind of inference the mind perceives that a given proposition implies a new truth whose subject and predicate are the original subject and predicate, each modified by the same limiting term. The character of the process, may be thus formulated: given S is P we may derive Sa is Pa. For example, from "A goldsmith is an artisan" we may infer "A crippled goldsmith is a crippled artisan," and from "Butlers are servants" we may infer "Butlers in uniform are servants in uniform."

The function of the added determinant is to decrease in the same degree the extension of both terms and to increase by the same amount the meaning of both terms. It is only when the added determinant does this that the inference is valid. Merely to use the same adjective as a modification of the subject and

predicate is not enough; care should be taken that the new word should produce the same effect upon the meaning and application of the original subject and predicate. There is need of special caution in the case of adjectives that are frequently employed to qualify objects of different sizes or in different spheres of thought. For example from "Gnats are animals" we cannot conclude that "Large gnats are large animals," though we may conclude that "Small gnats are small animals"; and from "A ballplayer is a man" we cannot pass to "A poor ballplayer is a poor man," unless we state that "poor" in both instances means "indigent."

2. EDUCTION BY OMITTED DETERMINANTS. It is obvious that a determinant which modifies a given subject and predicate in the same way as to meaning and application may be dropped from both terms with the effect of diminishing their intension and increasing their extension. For example, from "Honest judges are honest men" we may derive "Judges are men." Two such propositions have a relation of opposition. They are subalterns—the original the subalternant, the resultant the subalternate; and of course if the former is true the latter is true.

In all cases the determinant may be dropped from the predicate alone, as in passing from "Hereditary monarchs are hereditary rulers" to "Hereditary monarchs are rulers"; this is so because a subject that can bear the meaning of a species (the original predicate) can bear the meaning of the corresponding genus (the new predicate). On the contrary, the determinant may not usually be omitted from the subject alone when the latter is distributed. The omission is always possible, however, if the term modifying the

subject is an "essential epithet," such as "mortal" man, "wise" Solomon, and "yellow" gold. Thus, from "Black crows are black birds" we may drop the subject alone and pass to "Crows are black birds."

3. EDUCTION BY COMPLEX CONCEPTIONS. This is another sort of inference which involves an addition of the same element to both subject and predicate of a given proposition. The new term, however, is not a determinant but is itself determined. It is always a substantive which is restricted in meaning by the original subject and predicate as these appear in prepositional phrases. Examples: from "A hoe is a tool" we may infer "A man with a hoe is a man with a tool"; from "A rose is a flower" we may infer "The petals of a rose are the petals of a flower."

The inference gets its name from the fact that there is a transition of thought from a judgment in which the subject and predicate concepts are *simple* to one in which they are *complex*.

As in the case of Added Determinants, so in Complex Conceptions care should be taken not to add terms that convey equivocal ideas of quantity; thus we cannot conclude that because "Congressmen are citizens," "Half of the Congressmen are half of the citizens."

4. EDUCTION BY CONVERSE RELATION. In this form of inference the progress of thought is from a proposition in which the relation between two objects is expressed in one way to a proposition in which it is expressed in a converse way. In the given proposition one of the related terms is used as subject, and in the derived proposition the other term is used as subject. Examples: "Lear is the father of Ophelia" —"Ophelia is the daughter of Lear"; "A is greater

than B"—"B is less than A"; "The equator is south of Mexico"—Mexico is north of the equator."

In Converse Relation the copula of the given and educed propositions though apparently "is" or "is not" must really be considered to have some such form as "is more than," "is the cause of," "is related in space (or time) to." Hence we may find justification for the inference in the general statement that if two terms, A, as subject, and B, as predicate, are united by a copula of relation, they may also be united in reverse order (that is, with B as subject and A as predicate) by the copula of relation which the reversed order implies. For example, in the first of the foregoing illustrations, "Lear" as subject and "Ophelia" as predicate are united by a given copula of relation ("is the father of"). In the derived proposition "Ophelia" as subject and "Lear" as predicate are united by the copula of relation ("is the daughter of") which the reversed order implies.

A great deal of our thinking is occupied with transitions of this kind. In many cases of "saying a thing in two ways" the process of converse relation is at play. Thus there is clearly a choice of expression in the following examples: "The Ohio flows past Cincinnati" or "Cincinnati is located on the Ohio"; "John struck James" or "James was struck by John"; "The orator (is a person who) held the audience spellbound" or "The audience (is a gathering that) listened to the orator with rapt attention"; "The vine clings to the wall" or "The wall is covered with the vine"; "The house is built on the foundation" or "The foundation supports the house." But when one of a pair of such propositions is adopted as "given," a change to the other entails all the adroit

handling of new material which inference demands.

Converse Relation is by no means identical with Conversion. In Conversion the copula is always taken to be "is" or "is not" and the relation expressed is simple; whereas in Converse Relation the copula is made up of the word "is" and the word which designates the specific character of the relation. The difference may be illustrated as follows: *Conversion,* "All men *are* animals," "Some animals *are* men"; *Converse Relation,* "Man *is a species of* animal"—"Animal *is the genus* of man."

5. SUBSTITUTION. The practice of substituting one term for another is cultivated for the purpose of avoiding repetition and of securing variety and freshness in expression. Moreover, the process occurs so frequently that students are likely to seek approval for it in texts of Logic. An approval is easily given; for all the forms of eduction involve some change of matter, that is, some sort of substitution. To cover cases that may not have been included under the types of immediate inference which have already been discussed, it may be said in general that from a given statement a new proposition may be reached by substituting for the original subject or predicate or both (a) an equivalent or (b) an implied term, with of course appropriate changes in the copula when negative terms are supplied. As examples of (a) we may offer the following: from "Napoleon died at St. Helena" we may pass to "The Conqueror of Austerlitz died on an island in the Mediterranean"; from "Washington was the first President" we may pass to "The Hero of Valley Forge was the first Chief Executive." Examples of (b) are more varied. Thus, from "He walked all morning" we may derive "He

was moving about all morning" or "He was not inactive all morning"; from "He broke his leg in practice today" we may derive "He will not be in the game tomorrow"; from "Anyone who makes a noise will be dismissed" we may derive "Anyone who yells will be dismissed."

QUESTIONS AND EXERCISES

1. Define Education.
2. What new material may be found in an educed proposition?
3. Define Obversion. State the rule for Obversion.
4. Show that the obversion of affirmative propositions is based on the Law of Contradiction whereas the obversion of negative propositions is based on the Law of Excluded Middle.
5. Obvert the following propositions. Test the validity of your inference by noting whether the obverse stands revealed in the relation of the original subject and predicate as represented by Euler's circles.
   (1) Your dress should not be gaudy.
   (2) Each man wore a soft collar.
   (3) All but the tardy received presents.
   (4) A few of the leaks have been stopped.
   (5) There is a book on the table.
   (6) No non-Christian believes in the Incarnation.
   (7) Some citizens are not desirable.
   (8) None except the humble deserve to be admired.
   (9) This water does not run.
   (10) That remark is foolish.
6. Define Conversion. State the rule for Conversion.
7. On what grounds is the conversion of affirmative propositions justifiable?
8. On what grounds can you justify the application of conversion to a negative proposition?
9. What distinguishes the two kinds of conversion? What are they called?
10. Under what circumstances is the simple conversion of A propositions possible?

11. Under what circumstances may I propositions be converted into A?

12. Explain why O propositions cannot be converted?

13. Convert the following propositions. Employ Euler's circles to test the validity of your inference.

(1) Children are thoughtless.
(2) Not many of the regulars played.
(3) A stitch in time saves nine.
(4) Few of those who are called are chosen.
(5) All is not lost.
(6) Some of the men built a cabin.
(7) None of those will pass who failed to study.
(8) An organism is a living material substance.
(9) Mary preceded William.
(10) He said, "Might is right."
(11) All's well that ends well.
(12) Beneath this stone lies all that remains of John Brown.
(13) Only a saint could have made such sacrifices.
(14) Dust returns to dust.
(15) Some men have not seen the beauty of the stars.
(16) The President threw the first ball.
(17) Chickens are often counted before being hatched.
(18) All but the rich envy the rich.
(19) Man is a being that handles fire.
(20) Everybody will not go to heaven.
(21) Anybody can earn all that he needs to live on.
(22) Unafraid he faced the world.

14. Define Contraposition. State the rule for Contraposition.

15. Give the full contrapositive of some of the propositions in Questions 5 and 13.

16. Define Inversion.

17. Show that I and O cannot be inverted.

18. Give the full inverse of the following propositions:

(1) Everything to the right of the copula is the predicate.
(2) Birds are bipeds.
(3) The stars are not planets.
(4) No uncomfortable chairs were bought.
(5) A man who is kind has peace of mind.

19. Define Antithesis. Show that it may be regarded as a special instance of Inversion.

20. On what conditions may a proposition be treated antithetically? Take four propositions that meet these conditions and give the steps that lead to their antithesis.

21. Select three examples of material antithesis from the Book of Proverbs.

22. Is there a valid relation of antithesis between "Heads I win" and "Tails you lose?"

23. Define Education by Added Determinants.

24. What variation of extension and intension should follow upon Added Determinants? Illustrate.

25. What is Eduction by Omitted Determinants? What change of extension and intension does it produce? Illustrate.

26. May a determinant be omitted from subject or predicate at will?

27. What is Eduction by Complex Conception? Give an example.

28. What is Eduction by Converse Relation? In what does it differ from Conversion?

29. Name the eduction by which we pass from the first to the second of the following pairs of propositions and say whether the inference is valid.

(1) From "A lieutenant is a soldier" to "A learned lieutenant is a learned soldier."

(2) From "A needle is an instrument" to "A large needle is a large instrument."

(3) From "Conscientious voters are conscientious citizens" to "Voters are conscientious citizens."

(4) From "Wheat is grain" to "A carload of wheat is a carload of grain."

(5) From "Chicago is west of New York" to "New York is east of Chicago."

30. On what conditions may we infer by means of the substitution of terms?

31. State the relation between the following propositions: "The voluntary muscles are all striped." "The unstriped muscles are all involuntary." "A few of the striped muscles are involuntary."

32. By what process do we pass from each of the following propositions to the succeeding one?

(1) No spirits are bodies.
(2) All spirits are non-bodies.
(3) No bodies are spirits.
(4) Some non-bodies are spirits.
(5) Some spirits are non-bodies.
(6) Some spirits are not bodies.

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CHAPTER XVI

HYPOTHETICAL PROPOSITIONS

THE discussion of Categorical propositions has carried us rather far and we must go back a little to consider Hypothetical and Disjunctive propositions, the two other members of the division based on relation.

NATURE OF HYPOTHETICAL JUDGMENTS. *A hypothetical proposition asserts that two assumed judgments are related to each other as condition and necessary result.* The condition is called the *antecedent,* the result the *consequent;* for example, "If a nation is prosperous, its citizens are happy." An obvious purpose of the hypothetical proposition is to express an act of immediate inference. In our treatment of the various types of eduction we were, in fact, dealing with the relation of condition to necessary result, and had we wished in any case to set forth the relation in a single statement our proposition must have taken a hypothetical form. Thus, we found that the partial contrapositive of "Some old manuscripts are not legible" is "Some illegible writings are old manuscripts," and the logical connection between these two judgments could be announced in the proposition, "If some old manuscripts are not legible, then some illegible writings are old manuscripts." Of course it is not merely formal eductions

that fall within the scope of hypothetical enunciation; on the contrary, no instance of condition and necessary result is excluded.

The hypothetical conveys no information about the truth of either component judgment, and since assumption of the antecedent includes assumption of all its implications, the expressed relation imparts a belief concerning two assumed propositions. Nevertheless any doubt that may be entertained concerning the hypothetical is invariably associated with the antecedent; the inference from antecedent to consequent is always asserted to be necessary. It may not of course be necessary; hence a hypothetical proposition is false only when the condition named in the antecedent does not involve an implication of the consequent.

A hypothetical is introduced by the particle "If," or an equivalent word or phrase such as, "When," "Supposing that," "On condition that," "Provided that." Propositions beginning with such words and phrases as "Although," "Even if," "Notwithstanding that," "In spite of the fact that," are not themselves hypothetical but are to be regarded as denials of the connection between the antecedent and consequent of a hypothetical announced or understood. The statement "In spite of the fact that clouds are gathering, it will not rain," is directed against the assertion, or at least the thought, "If clouds are gathering it will rain."

It should be noted that the antecedent and consequent may, taken separately, have the same or a different quantity and quality; as independent judgments they may be either A, E, I, or O. Hence the type of the components is not a mark of distinction.

Strictly speaking the hypothetical has no quantity; and it has quality only in the sense that it always affirms the connection between propositions. For instance, there is no difference in the function of the hypotheticals in the following cases: A declares, "If he comes I will go"; B declares, "If he does not come I will go." These propositions do not contradict each other, they are simply independent hypotheticals. A's declaration could be contradicted by the retort, "Even if he comes you will not go" and B's declaration by the retort, "Even if he does not come you will not go." Naturally, the connection between antecedent and consequent can be denied categorically, but the only way in which it can be denied inferentially is, as our examples indicate, *to retain the given antecedent and negate the quality of the consequent.* The verbal changes necessary to bring out the distinction between contrary and contradictory denial will appear a little further on in the treatment of the opposition of hypotheticals.

THE TWO HYPOTHETICAL TYPES. Depending upon whether the components have the same or different subjects, the hypothetical is generally said to exhibit a variation in form. Thus, the arrangement of terms may be (A) If S is M, it is P; or (B) If A is B, C is D.

A. The *first form* is usually employed as a means of fixing the interpretation of universal truths, especially those that are expository in character. In fact the only way of expressing the full import of expository truths is to declare them hypothetically. For instance, the categorical, "All men are mortal" does not so well avoid the restriction of the predicate to existing men as the statement "If a being is a man

that being is mortal." On the other hand, this hypothetical form is not well adapted to the enunciation of enumerative general truths. For instance, the men in a class might upon investigation be found without exception to be studious, and the discovery might be announced in a hypothetical, "If he is a man in this class he is studious"; yet this form would seem to suggest that being studious pertains to the men not as men but as members of the class—a meaning that the facts do not support. The categorical "All the men in this class are studious" would convey the limited thought much more satisfactorily.

B. The *second form* is obviously employed to express a perceived relation between two judgments which might be true independently. Indeed it is a test of this form as distinguished from the other that either antecedent or consequent makes complete sense when standing alone. Thus, "If a miracle had been wrought they had long ago done penance" sets forth a relation between two propositions which could also be considered out of relation. In a narrative, for instance, it might be stated first, "They had long ago done penance," and later on, "A miracle had been wrought."

OPPOSITION OF HYPOTHETICALS. Although hypothetical propositions lack the quantity and quality of the categorical types, they display a fourfold opposition by reason of the way in which their logical connections are related. Thus in a given hypothetical, the connection may be such that (a) all cases in which the antecedent is fulfilled are followed by the consequent; (b) no cases in which the antecedent is fulfilled are followed by the consequent; (c) some cases in which the antecedent is fulfilled are

followed by the consequent; (d) some cases in which the antecedent is fulfilled are not followed by the consequent. These possibilities present a manifest analogy to categorical opposition which may be illustrated in the following parallels:

A All crows are black—If a bird is a crow it is black.
E No crows are black—If a bird is a crow it is not black.
I Some crows are black—Sometimes when a bird is a crow it is black.
O Some crows are not black—Sometimes when a bird is a crow it is not black.

Evidently each of the foregoing hypotheticals, corresponding to the categorical type it is associated with, might be placed upon a Square of Opposition. The word "sometimes" is of course used in the logical sense of "sometimes at least, perhaps always."

EDUCTION OF HYPOTHETICALS. The various forms of eduction can be applied to hypotheticals. A few examples will suffice to show what verbal changes are necessary in order to bring about obversion, conversion and contraposition; and with these processes understood the other kinds of eduction will offer no difficulties.

1. Obversion

(a)	Obvertend	Sometimes when a man is an artist he is a painter.
	Obverse	Sometimes when a man is an artist it is not the case that he is not a painter.
(b)	Obvertend	If a man is envious he is not happy.
	Obverse	If a man is envious it is not the case that he is happy.

2. Conversion

(a)	Convertend	If a stone is a diamond it is rare.
	Converse	Sometimes when a stone is rare it is a diamond.

(b)	Convertend	If a man is spiritual he is not coarse.
	Converse	If a man is coarse he is not spiritual.
3.	Contraposition	
(a)	Original	Sometimes when a stream is a river it is not the case that it is swift.
	Obverse	Sometimes when a stream is a river it is the case that it is not swift.
	Converse	Sometimes when a stream is not swift it is a river.—Partial contrapositive.
(b)	Original	If a man is a criminal he is despised.
	Obverse	If a man is a criminal it is never the case that he is not despised.
	Converse	If a man is not despised it is never the case that he is a criminal.—Partial contrapositive.

THE CONDITIO SINE QUA NON. Reference to the foregoing examples will show that the conversion of hypotheticals requires in some cases to be made *by limitation*. This is ordinarily true when—as in example (a) under Conversion—the components are both affirmative judgments and the antecedent is not restricted by the word "sometimes." But even if the components are affirmative and even if the antecedent is restricted, *unlimited conversion* is possible provided the ground of inference is a *conditio sine qua non*—in other words, provided the consequent never occurs unless the antecedent is fulfilled.

Whether the antecedent is the sole ground of inference is often an important question. It can be settled easily in the case of a proposition introduced by such words as "Only when," "Never unless," "Never except when," for these are signs which expressly indicate the exclusive character of the condition. Hence, "Never except when the sun is low are the shadows of daylight long," may be converted without limitation into, "If the shadows of daylight are long the

sun is low." In all other cases, however, the question must be settled by ascertaining the nature of the matter with which the hypothetical deals. As a rule exclusive conditions are confined to propositions in which the subject of antecedent and consequent is the same. When at all events the hypothetical is of this type and the predicate of the consequent is a *definition* or a *property* or an *implied attribute*, conversion without limitation is possible. Thus we may pass from "If a being is a man, that being is a rational animal" to "If a being is a rational animal, that being is a man"; from "If a triangle is equiangular it is equilateral" to "If a triange is equilateral it is equiangular"; from "If a thing is a cause it has an effect" to "If a thing has an effect it is a cause."

To say that the condition in a given hypothetical is not the sole ground of inference is the same as saying that the consequent may follow from one or more other conditions. Accordingly when this is the case —and it is invariably so except in the instances noted in the preceding paragraph—although the affirmation of any of the conditions will necessitate the affirmation of the consequent, the negation of any of them will not require the negation of the consequent; on the other hand, although the negation of the consequent will tell us that neither the condition expressed nor any of the others has been fulfilled, the affirmation of the consequent cannot tell us that the condition expressed rather than any of the others has been fulfilled. Hence for purposes of inference the following rule is laid down: *Affirm the antecedent and you affirm the consequent, but not vice versa; deny the consequent and you deny the antecedent, but not vice versa.*

HYPOTHETICALS AND CATEGORICALS. We have seen that enumerative general truths are improperly announced in hypothetical propositions, whereas expository general truths miss a shade of implication when they are given categorical expression. The two forms then are radically distinct. To set forth a truth in both ways, however, is usually possible and often advisable.

It is always possible, for instance, to reduce hypotheticals of the first type to categoricals by making verbal changes corresponding to the difference between the formula, "If S is M it is P," and the formula, "Every SM is P." Thus, "If a man is virtuous he is respected," may be reduced to "Every man that is virtuous is respected" or "All virtuous men are respected." The reduction of the second type of hypotheticals frequently results in distortions that can serve no good purpose. Yet this is not always true, as the following examples will show: "If a nation is prosperous its citizens are happy"—"The citizens of a prosperous nation are happy"; "If these miracles had been wrought at that time the people would long ago have done penance"—"The working of these miracles at that time would long ago have led the people to do penance."

The value of interchanging the form of propositions may be illustrated by showing that the rule of inference limiting affirmation to the antecedent and denial to the consequent of hypotheticals can be more easily understood if it is read with reference to the relation of subject and predicate in categoricals. It is true of a typical A proposition that its undistributed predicate can be affirmed of more subjects than the one it is expressly related to. Thus, Dogs are verte-

brate, but so are men, horses, deer, tigers, etc. To say an animal is a vertebrate, therefore, gives no hint about the kind of vertebrate it may be; but to deny it is a vertebrate is to exclude it from any of the classes that are vertebrates. Again, since the subject of a typical A is by way of being a species of the predicate, to say an animal is a dog compels one who knows the animal in its specific character to apply to it the generic attribute; but to deny an animal is a dog leaves the question of its being a vertebrate entirely open.

QUESTIONS AND EXERCISES

1. Define a hypothetical proposition.
2. Show that any relation of immediate inference may be fully expressed in a hypothetical proposition.
3. Construct four hypothetical propositions beginning with four different signs.
4. What do the signs "Although," "Even if," "Notwithstanding that" indicate?
5. Does the second of the following propositions deny the first? If not, how may the first be denied? "If the charge explodes the ship will be ruined." "If the charge does not explode the ship will be ruined."
6. What distinguishes the two types of hypothetical propositions? Symbolize each.
7. What advantage has the first type as a means of expressing certain universal propositions?
8. What is the test of the second type?
9. Show that there is an analogy between the four categorical types as placed on the square of opposition and the four relations that may be expressed in hypothetical propositions.
10. Obvert the following hypotheticals:
    (1) Sometimes when a man is ill his work goes on.
    (2) If a pitcher goes to the well often enough it will be broken.
    (3) If no surplus is shown the owner cannot continue the business.

11. Convert:
    (1) If food is not digested it is injurious.
    (2) If a book is immoral it is not readable.
    (3) Sometimes when the sun sets the sky is green.
12. Contraposite:
    (1) Sometimes when a man is a politician it is not the case that he is honest.
    (2) If an act is moral it conforms to God's will.
    (3) If a person is an administrator it is not the case that he is self-sufficient.
13. What is meant by a *conditio sine qua non?* By what signs may such a condition be indicated?
14. What is usually the character of the predicate of the consequent when the antecedent is a *conditio sine qua non?*
15. Give two hypothetical propositions in which the antecedent is the sole condition; then convert them.
16. If you affirm the consequent of a hypothetical do you necessarily affirm the antecedent, and if you deny the antecedent do you necessarily deny the consequent? Explain your answer.
17. Reduce the following hypothetical propositions to categorical form:
    (1) If a poem is beautiful it will be a joy forever.
    (2) If a judge is honest he will not take a bribe.
    (3) If the river freezes tonight our boat will be icebound.

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CHAPTER XVII

DISJUNCTIVE PROPOSITIONS

THE DISJUNCTIVE FORMS. A disjunctive proposition asserts that of two or more suppositions one is true. The suppositions, usually called "alternatives" are disjoined by means of the words "either—or." Three sorts of disjunction are possible depending on whether a statement presents a choice of subjects, of predicates, or of complete propositions. Hence the following forms and illustrations: Either A or B is C—"Either the First or Second Regiment will be sent"; A is either B or C—"Tides are either ebb or flood"; Either A is B or C is D—"Either the mountain will come to Mohammed or Mohammed will go to the mountain."

Alternatives can of course be offered negatively, but only by means of the particle "not." "Neither—nor," which might at first sight appear to be the negative substitute for "either—or," will always have the effect of conjoining two or more negatives. Thus to say "That tree is neither a maple nor an elm" would plainly deny the possibility of its being the one or the other. A choice of denials could be provided for by saying "That tree is either not a maple or not an elm."

DISJUNCTION AND DIVISION. The kind of thinking that finds expression in disjunctive propositions

is closely associated with the process of analyzing concepts, especially with the process of division. Disjunctives that presuppose partition are common enough, as for example, "Either the left leg or the right was broken"; "The scissors are either in the hall or in the pantry." But perhaps more common still are disjunctives that set forth a division in propositional form, as for example, "Oblique angles are either acute or obtuse"; "Poetry is either lyric, didactic, dramatic or narrative."

Now the fact that disjunctive propositions are virtually the result of analyzing concepts throws light on the nature of alternate predication. The very purpose of division—and the same is true of partition with reference to the whole and its parts—is to separate the members of a class so that they shall be mutually exclusive. Once this is done an object within the genus (the divided concept) must belong to one specific group and not to any of the others—the principle on which alternate predication is based. In disjunctives of the first type it is the predicate that is generic in character and the subject embraces the various sub-classes, as for instance, "Either the men or the women will sit on this side"; in disjunctives of the second type the subject is generic and the predicate includes the sub-classes, as for instance, "Lilacs are either white or purple"; and even in disjunctives of the third type the alternate judgments should be regarded as possible cases in a situation or group of circumstances, the cases being parts with reference to the situation or group of circumstances as a whole. Usually the parts alone are given expression; but this is not always so, and sometimes we meet with such propositions as "This is the situation: either the

mountain will come to Mohammed or Mohammed will go to the mountain."

Since disjunction and division are so nearly alike it would appear that the rules for division should be kept in mind while one estimates the import of alternative predication. As a matter of fact the ideal disjunctive does conform to these rules; for the alternatives (a) exhaust the analyzed concept, (b) are mutually exclusive, and (c) depend on a single basis. Moreover it is only when these conditions are met that anything like free inference from the disjunctive is possible.

THE DISJUNCTIVE PURPOSE

The strict purpose of disjunctive expression, then, is to limit the choice of alternatives so that if one is true any other must be false. The formula "A is either B or C or both" is serviceable, as we shall see, in only one kind of argumentation. Consequently, disjunctives are generally intended to carry the import that if one of the alternatives is accepted the other or others must be rejected, and if every alternative save one is rejected that one is true. Obviously the second phase of this import is the more practical. Indeed when a disjunctive is announced the mind tends at once to eliminate the possibilities and thus put itself within closer reach of the truth. Even before announcement elimination often occurs and is accordingly taken for granted. Hence not all disjunctives that omit alternatives are incomplete: for example, the proposition, "The scissors are either in the hall or in the pantry" may carry the understanding that they are definitely in no other part of the house; or the proposition, "The next act will be either the Second or the Third" may be regarded as exhaustive

on the ground that it is too late for the First act and too early for the Fourth.

PROPOSITIONS WITHOUT THE DISJUNCTIVE PURPOSE. Occasionally propositions although disjunctive in form are not intended to identify a term with one class rather than another. For example, the statement "Either the Senate or the House will vote against the bill" may mean that the bill will be defeated, perhaps by a majority of both assemblies; the assertion "He was a painter or a sculptor" may have no other purpose than to declare that the man was an "artist."

THE LOGICAL ATTITUDE TOWARD DISJUNTIVES. In view of the loose manner in which alternate predication is sometimes made it would be well to consider disjunctives with reference to the following rule: *Unless we know the intention behind the thought we have no right to go beyond that interpretation which carries the least implication.* Since, however, knowledge of the purpose is often revealed in a context of written or oral language a fuller implication is sometimes possible and should be taken advantage of.

DISJUNCTIVES AND HYPOTHETICALS. Although, as we have seen, it cannot be admitted that these two forms are radically the same, a thought announced disjunctively can easily be given hypothetical expression and vice versa. Thus, "If he does not come I shall go" may be rendered "Either he will come or I shall go," and "A poet is either born or made" may be treated hypothetically in four ways:

If A is B it is not C—"If a poet is born he is not made."
If A is not B it is C—"If a poet is not born he is made."

If A is C it is not B—"If a poet is made he is not born."
If A is not C it is B—"If a poet is not made he is born."

DENIAL OF DISJUNCTIVES. In so far as alternate predication is meant to afford a restricted choice of possibilities, it may be denied in two ways: first by a categorical in which the sign "Neither—nor" appears; and second by a categorical which affirms "both" alternatives. Thus the choice offered in the statement, "A soldier is either an officer or a private" is removed not only by the judgment, "A soldier is neither an officer nor a private" but also by the judgment, "A soldier is both an officer and a private." Of course the first of these so-called "remotive" propositions is a complete denial of the possibilities as well as the choice; on the other hand the second while it denies the choice really affirms the possibilities. Accordingly the second form of the remotive is from one point of view the contradictory of the original and from another its subalternant, for if the remotive is true the original is true but not vice versa and both may be false.

CATEGORICALS WITH THE SIGN "NOT BOTH." The categorical form, "No soldier is both an officer and a private" is not a denial of the original but merely another way of expressing it. Hence categoricals which carry the sign "not both" are always interchangeable with disjunctives. It should be noted, however, that reduction of such categoricals to disjunctives in which a choice is offered both affirmatively and negatively is possible when the terms of the choice are contradictories, but not when they are contraries; when they are contraries the choice must be offered *negatively*. For example, given the cat-

egorical, "No animal is both vertebrate and invertebrate," we may reduce to "An animal is either vertebrate or invertebrate," or "An animal is either not vertebrate or not invertebrate"; but given "No man is both wise and foolish," we may not reduce to "A man is either wise or foolish," but may reduce to "A man is either not wise or not foolish."

EDUCTION OF DISJUNCTIVES. Immediate inference from disjunctives is of course possible, though not at all common. An example of full contraposition will suffice to show the more important processes; thus, by *obverting* "A sonnet is either Petrarchan or Shakespearean," we may pass to "No sonnet is both non-Petrarchan and non-Shakespearean"; by *converting* this result we may educe, "No verse form that is both non-Petrarchan and non-Shakespearean is a sonnet," and finally by obverting again we reach the full contrapositive "A verse form that is both non-Petrarchan and non-Shakespearean is one that is not a sonnet."

QUESTIONS AND EXERCISES

1. What is a disjunctive proposition? What are its signs?
2. On what do the three forms of disjunctive propositions depend? Give their symbolization.
3. What is the function of "Neither—nor?" Illustrate.
4. How may a choice of denials be provided for? Illustrate.
5. Show the bearing of disjunctive judgments upon the processes of partition and logical division.
6. In the first type of disjunctive proposition what relation has the predicate to the alternate subjects?
7. In the second type of disjunctive proposition what relation has the subject to the alternate predicates?
8. Show that a similar relation exists in the third type.
9. What three conditions must exist in order that there may be unrestricted inference from a disjunctive proposition?

10. What is the strict purpose of the disjunctive?

11. Does the proposition "The man was either a Malay or a Japanese" carry an incomplete disjunction? Could it under any circumstances be regarded as having the strict disjunctive purpose?

12. Give a proposition which has the disjunctive form but which can be explained as not having a disjunctive purpose.

13. Express hypothetically in four ways the proposition, "Either the Whites or the Blacks are culpable."

14. Given the proposition "Either Seniors or non-Seniors are excluded," what is the force of the counter propositions (a) "Both Seniors and non-Seniors are excluded" and (b) "Neither Seniors nor non-Seniors are excluded?"

15. Express the following categoricals in disjunctive form:
    (1) No jewel is both costly and non-costly.
    (2) No play is both very good and very bad.

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CHAPTER XVIII

MEDIATE INFERENCE: THE SYLLOGISM

IN the case of Immediate Inference, thought progress is based on the implications that lie in the relation of *two* concepts, the subject and predicate of a judgment. On the other hand Mediate Inference, usually called Reasoning, issues out of the implications that lie in the relation of *three* concepts, one of these being a common term with which the other two are compared. Accordingly the truth that results from Mediate Inference follows upon the mind's perception of the relation which three concepts show in two judgments. Two propositions are of course necessary to set forth the data, yet considered separately they do not constitute the data; and the third proposition announcing the new truth is not a consequent of them but of the conceptual relations they signify. The most familiar though not the only kind of mediate inference is expressed in the Syllogism, and a study of this form will serve to reveal the essential characteristics of reasoning.

THE SYLLOGISM

DEFINITION: *a syllogism is the expression of an act by which the mind seeing the implication involved in two given judgments, one at least a universal and both containing a common concept, passes with cer-*

tainty to a new judgment in which the common concept does not appear. The following example is typical:

All birds are bipeds
All larks are birds
∴ All larks are bipeds.

Or in symbolic form:

MaP
SaM
SaP

The propositions which contain the common term are called the "premises," the other is called the "conclusion." The common term itself is called the "middle"; the other two the "major" and "minor." The terms derive their names from the order in which they stand to one another as logical parts to a logical whole. A logical part as distinguished, for instance, from a physical part is not merely numbered within the whole but carries the same meaning as the whole, participates in the nature of the whole. Now in the standard syllogism, such as our example represents, there is a definite order between the terms based on this idea of a *common meaning running through them all.* The common meaning, indeed, holds the terms together and forms them into a logical or conceptual system. In a typical A proposition the subject may be regarded as a species with reference to the predicate as a genus; and since the premises under consideration are both A, it is plain that the subject of the second proposition is a species compared with its predicate, and this predicate in turn as subject of the first proposition is a species compared with its predicate. In other words the term common to both

premises is a genus as well as a species and consequently holds a mean logical position between the other two, one of which is a genus only, the other a species only. As distinguished then from the genus above it and the species below it the common term is called the Middle. All the terms share the same meaning but they do not apply it in the same way; in comparison with the middle the predicate of the first premise carries the meaning to a greater number of individuals and for this reason is regarded as the Major term; on the other hand in comparison with the middle the subject of the second premise carries it to a smaller number of individuals and is accordingly the Minor term. Thus in our example the meaning "bipeds" is extended by the major term to the whole universe which bears that name, it is extended to a smaller class by the middle term "birds" and to a still smaller class by the minor term "larks." In such instances, the function of the middle is, as it were, to draw the meaning out of the major and transmit it to the minor.

Of course when the first premise is a negative proposition its predicate does not stand to its subject as a whole (a genus) to its part (a species). Moreover, syllogisms other than the standard do not show the relations which furnish the reasons we have just given for naming the terms. In view of these facts and because the terminology is the same in all cases there must be a general rule for recognizing the various elements. This rule is as follows: *the Minor term, symbolized by S, is the subject of the conclusion, the Major term, symbolized by P, is its predicate, and the term which does not occur in the conclusion is the Middle, symbolized by M.*

Since the order of propositions observable in the standard syllogism is not followed in every instance, it also becomes necessary to point out that the major premise is the one which contains the major term, the minor premise the one which contains the minor term.

MATTER AND FORM. It is customary to draw a distinction between the matter and form of a syllogism. *The three terms comprise the matter, and the announced relations that exist between them constitute the form.* Although as we have already seen, these two elements are really inseparable inasmuch as neither would be what it is without the influence of the other, nevertheless for purposes of explanation we can conceive the form to change while the matter remains constant or the matter to change while the form remains constant. It is the latter point of view that the logician adopts in presenting the syllogism as a process of reasoning. His concern is to show what necessarily follows from a given set of relations. The relations themselves may not square with reality because of the matter they involve; in that case the conclusion will not be true either, though it will still be necessary. Hence the acquaintance with the rules of mediate inference will assure us only that when the premises are true separately and when together they bring their concepts into certain relations the conclusion not only inevitably follows but is also true.

THE AXIOMS OF THE SYLLOGISM. All forms of reasoning rest upon the Laws of Thought and consequently the force with which any syllogism compels assent has its origin in one of the first principles. In the case of categorical syllogisms, for instance, affirmative conclusions may be tested by the Law of

Identity and negative conclusions by the Law of Contradiction. There are, however, more proximate sources from which mediate inference may be seen to take its rise, and these are called axioms.

1. GENERAL AXIOM. There is only one axiom which is applicable to all forms of the categorical syllogism and this may be given the following twofold statement:

A. Two concepts identical with the same third are identical with each other.

B. Two concepts, one identical, the other not identical with the same third are not identical with each other.

It is evident that of these two axioms (A) shows but little variation from the Law of Identity and (B) is merely a somewhat fuller expression of the Law of Contradiction.

2. DICTUM DE OMNI ET NULLO. This, rather than the preceding axiom, furnishes us with a real instrument for studying the nature of the syllogism. The name of the axiom is an abbreviation of its twofold Latin rendering:

Dictum de omni dicitur de singulis
Dictum de nullo negatur de singulis.

The full import of the principle is contained in the following adaptation of a familiar Scholastic form: What is affirmed or denied of a whole may be affirmed or denied of any part of that whole. Applying the axiom to our example of the standard syllogism we may say: It is affirmed of a whole ("all birds") that they are "bipeds;" consequently it must be affirmed of a part of that whole ("all larks") that they too are "bipeds." It should be understood that

the words "whole" and "part" refer to a *logical* whole and a *logical* part.

The axiom can be applied directly only to what we have been calling the standard type; to what Aristotle called the perfect figure of the syllogism. This, however, does not diminish its value, because all the other figures may be reduced to the perfect figure and are thus quite within the scope of the principle.

THE ENUMERATIVE MAJOR PREMISE AND THE DICTUM. Argumentative forms sometimes fail to exhibit the force of argument, and "reasonings" that lack the compelling power of inference are occasionally to be met with in the guise of syllogisms. "Proofs" like the following, for example, are comparatively common: "John was smoking, because he was in the room, and all the men in the room were smoking." Now it is easy to see that the *Dictum de Omni et Nullo* cannot be applied to a case of this kind. The proposition which holds the place of the major premise in the example is an enumerative universal, that is, a general statement which is the result of specifically relating the predicate to every individual denoted by the subject. Accordingly the subject is not a logical but a collective whole. Indeed the subject of an enumerative universal, although a collective whole, is never more than a logical part; because the predicate is always in the category of "accident" and can therefore be thought of as absent from the nature which happens to possess it. Thus the proposition "All the men in the room were smoking" means no more with reference to the class "human beings" than that "Some men were smoking." It is true that sometimes the predicate of a collective whole is supposed to be essential to the nature of the individuals

it embraces in so far as they properly belong to that whole, as, for instance, to carry arms seems essential to being a soldier; however, on the supposition made in such cases the predicate falls into the category of either "genus" or "differentia" (or perhaps "property") and consequently the universal is not enumerative but expository. Of course in our example the conclusion is true, yet it is not an inference. The major premise, "All the men in the room were smoking" could not be announced unless the conclusion were actually known beforehand. The *Dictum* then has no meaning as applied to a collective whole, for nothing can be predicated of such a whole that has not already been explicitly predicated of every one of its parts.

THE MAJOR PREMISE A TRUE UNIVERSAL. In order to carry the force of argument a syllogism must have as its major premise an expository universal. The purpose of the expository universal is not directly and expressly to denote the individuals that bear a given predicate but rather to exhibit the predicate as part of the nature of the subject. For this reason it was pointed out that true universals lose some of their import unless they are set forth in hypothetical form. The antecedent of a hypothetical proposition, corresponding to the subject of a categorical, may or may not be fulfilled; but until it is fulfilled the consequent, corresponding to the predicate, can never be said to exist. Hence our assurance that the predicate (the major term) actually belongs or does not belong to a part is always inferential, and rests definitely upon the affirmation that the part (the minor term) is a member of the whole (the middle

term). Thus to say "All elves are dwarfs" is true in the sense that "If a being is an elf it is a dwarf." As the proposition stands, it is a potential source of further knowledge, yet it can never be more than that until some "beings" are declared to be "elves." When this is done, the predicate receives a real as distinguished from a mere potential application, and the problem whether it ever can be used in an actual case is solved. Surely there is here a sufficient advance in thought to constitute inference. If then the major premise is read in intension and the minor in extension, a syllogism of the type we have been considering will meet all the requirements of the *Dictum* and display the marks of true reasoning.

THE SYLLOGISM NOT A BEGGING OF THE QUESTION. It has been objected that even when the major premise is a true universal the syllogism amounts to a begging of the question, a fallacy in which a judgment that needs to be proved is offered as proof of itself. The objection is often rendered plausible by reason of the familiar illustrations employed in driving it home. Thus it is said that in the syllogism, "All men are mortal, James is a man, therefore James is mortal," the premises cannot be known separately; for if "mortality" is an essential characteristic of "all men," "James" must be known to possess it before he can be called a man; consequently the conclusion "James is mortal" is assumed in the statement "All men are mortal"—an obvious begging of the question.

In this example the major term represents a quality which because it is so commonly attributed to human nature, is seldom absent from consciousness when the

mind judges that a certain being is a man. But let us take a syllogism in which the major term has no such familiar association with the nature denoted by the middle, for instance:

All who were exposed to smallpox are going to be vaccinated
All the members of the class were exposed to smallpox
∴ All the members of the class are going to be vaccinated.

In this case it is plain that one may have knowledge of either the major or the minor premise alone; it is only when both propositions are brought together and the terms thus put in the relation of logical part to logical whole that an inference is possible. As a rule all the essential attributes of a nature are not and need not be known before it can be identified with an individual or a class.

The fact is we seldom attain to a complete intension of a concept, yet for purposes of identification an understanding of its partial intension is quite sufficient. It is conceivable, for instance, that "mortality" should not be included in the intension of "man" before "James" could be identified as a man; and if this were so there would be no begging of the question in the syllogism first quoted. Certainly there is no begging of the question in the second syllogism; we could be very well aware that the members of a class were exposed to smallpox without knowing that those who were exposed were going to be vaccinated. Indeed we might be informed—through an ordinance, for instance—that any persons exposed to smallpox would have to be vaccinated, and at the same time be altogether ignorant of the existence of

such persons. Moreover no one could be compelled to undergo vaccination unless it were first proved that he was exposed. Surely there is no begging of the question in such a case as this. The objection, therefore, while it is valid against syllogisms with an enumerative major, has no force against syllogisms in which the major premise is a true universal—provided of course, the full intension of the middle term (including the attribute signified by the major term as essential) is not in mind when the minor is identified with the middle.

KINDS OF SYLLOGISMS. Besides the type of syllogism with which we have been dealing in order to establish a definition and explain the source and value of this form of reasoning, there are other types which should be referred to now by way of indicating the topics that will engage us in the next few chapters. Since mediate inference results from a perception of the implications that lie in the expressed relations of three terms, a division of syllogisms can be based on the kinds of propositions employed to set forth these relations. There are three possibilities.

1. If the propositions are all of one kind the syllogism is called "Pure;" if they are of different kinds it is called "Mixed."

2. If the major premise is hypothetical or disjunctive and the minor premise categorical, the syllogism is called a Mixed Hypothetical or a Mixed Disjunctive.

3. If the major premise is hypothetical and the minor premise disjunctive the form receives the special name of Dilemma.

The following table shows the division in detail:

- Syllogisms
  - 1. Pure
    - (a) Categorical
    - (b) Hypothetical
  - 2. Mixed
    - (a) Hypothetical
    - (b) Disjunctive
    - (c) Dilemma

We shall continue our treatment of the syllogism with a further discussion of the categorical form and then consider in turn hypothetical and disjunctive reasoning.

QUESTIONS

1. What is the essential difference between immediate and mediate inference?
2. Explain the statement that "mediate inference follows upon the mind's perception of the relation which three concepts show in two judgments."
3. Define a syllogism.
4. Explain that in a typical syllogism composed of affirmative propositions there is a common meaning running through all the terms, and that this meaning is the constitutive element of a logical or conceptual system.
5. From what point of view have the three terms of a syllogism been given their respective names?
6. In general how are the major, minor and middle terms located? Give the symbol for each.
7. Define the matter and form of a syllogism.
8. What is meant by an axiom of the syllogism?
9. State and apply the General Axiom.
10. State Aristotle's *Dictum de Omni et Nullo.*
11. Explain its application to examples (affirmative and negative) of the standard type of syllogism.
12. Discuss the statement that Aristotle's *Dictum* does not support an argument whose major premise is an enumerative universal.

13. What is meant by saying that the syllogism is a begging of the question?

14. Prove that it is not a begging of the question.

15. Give an example which will meet the tests of genuine reasoning; namely, that the premises can be independently known without an explicit knowledge of the conclusion.

16. On what basis are syllogisms generally divided?

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CHAPTER XIX

RULES OF THE SYLLOGISM

WE have seen that a syllogism is an effective instrument of reasoning only in so far as it conforms to the *Dictum de Omni et Nullo*. It can be further shown that the general rules of the syllogism are directly deducible from this axiom. Before tracing their origin, however, it may be advisable to present the following Statement of the Rules:

1. There should be three and only three terms.
2. There should be three and only three propositions.
3. The middle term must be distributed at least once.
4. Unless the minor or major term is distributed in its premise it may not be distributed in the conclusion.
5. At least one of the premises must be affirmative.
6. If one of the premises be negative the conclusion must be negative; and in order to prove a negative conclusion one of the premises must be negative.

The next two items are usually given as Corollaries.

7. From two particular premises nothing can be inferred.
8. If one premise is particular the conclusion must be particular.

DERIVATION OF THE RULES FROM THE DICTUM

1. There are three and only three terms because the axiom mentions merely "a whole," its "part," and a "predicate" which is affirmed or denied of these.

2. There are three and only three propositions, as may be gathered from the wording of the *Dictum*: "What is (a) affirmed or denied of a whole may be (b) affirmed or denied of any class or individual (c) declared to be part of that whole."

3. The major term has to be affirmed or denied of a whole, namely, a concept in its generic capacity —a logical whole—representing a nature possessed by every individual of a class. But this whole is always the middle term; hence in the type of syllogism to which the *Dictum* directly refers the middle term must be distributed, and since all the other types are reducible to the standard, the middle term in any case will have to be distributed.

4. The fourth rule affects the quantity of the major and minor terms in the conclusion. As for the minor term, the *Dictum* says that affirmation or denial is finally to be made of that part of the class —species, individual, or indefinite number of individuals—which is included in the whole; hence that part, and not a more extensive part, must be employed as subject of the conclusion. As for the major term, the *Dictum* provides that the predicate should be related to the part exactly as it is related to the whole; if then this predicate—the major term—is undistributed in its premise, that is, affirmatively related to the whole, it should remain undistributed in the conclusion, that is, affirmatively related to the part.

To distribute it would be in effect to make a different sort of predication.

5. The *Dictum* calls for the judgment that a part is included in a whole. Such a judgment, however, can be expressed only in an affirmative proposition. Therefore one of the premises must be affirmative.

6. According to the *Dictum* if the major term is denied of the whole it must be denied of the part; but the place of the second denial is the conclusion; consequently, if the major premise be negative, the conclusion must be negative. Similarly, there can be no exclusion of the major term from a part except as a consequence of its exclusion from the whole; hence, if the conclusion is to be negative, the major premise must be negative.

The corollaries also can be deduced from the axiom, provided we still regard it as referring to the standard type.

7. In the standard type the major premise cannot be particular, since the middle term must be distributed, and it is not distributed in the minor premise which is always affirmative [Rule 5] with the middle term as an undistributed predicate. But if the major premise be universal, the corollary is proved. Of course this explanation will not hold good for all the figures.

8. The only premise which can be particular in the standard type is the minor, but if this is particular the minor term in the conclusion must be undistributed, otherwise Rule 4 would be violated.

Violation of the rules of the syllogism renders inference impossible; consequently, one way of showing their force as guiding principles is to point out why thought makes no advance when they are not applied.

Failure to observe the rules is technically called a fallacy. Fallacies due to the language in which an argument is expressed may be *material,* involving the meaning of the terms employed, or *formal,* involving the relation in which they are presented. Material fallacies will be given special treatment further on, but since formal fallacies are more directly the result of infractions of the rules they require immediate consideration.

FORMAL FALLACIES

1. QUATERNIO TERMINORUM, or a Four-term Construction. An attempt to reason with four univocally distinct terms would constitute a *formal* fallacy of this sort. The absurdity of such a procedure needs no illustration. *Material* fallacies concealing a four-term construction are so common that it may be well to anticipate their special treatment by a general reference to them. Rule 1 is violated whenever in the course of reasoning a term is used twice in different senses. Such unwarranted changes in the matter give rise to the fallacy of Shifting Terms. Naturally the middle term lends itself most readily to equivocation, hence a *Quaternio Terminorum* which needs to be particularly guarded against is that of Ambiguous Middle. The following is a rather obvious example:

Clerical work is a business occupation
Preaching is clerical work
∴ Preaching is a business occupation.

In the major premise of this syllogism "clerical" means "pertaining to a clerk" whereas in the minor it means "pertaining to a clergyman."

2. A form which illustrates a breach of Rule 2 can hardly be given. Two propositions with the

same matter in their subjects and predicates might represent immediate but not mediate inference; and four propositions offered as an expression of reasoning would inevitably carry more than the three terms permitted by Rule 1.

3. UNDISTRIBUTED MIDDLE. This formal fallacy—a result of violating Rule 3—is committed in the following example:

All Frenchmen are Europeans
All Parisians are Europeans
∴ All Parisians are Frenchmen.

In testing this and indeed all other syllogistic forms, the use of Euler's circles will help to make clear whether the relation announced in the conclusion is necessarily implied in the relations as set forth in the premises. It should be remembered, however, that although the circles directly symbolize relations of extension, they can also bear an interpretation based on intension. Fig. I represents all that the premises of our example compel us to show with regard to the term relations.

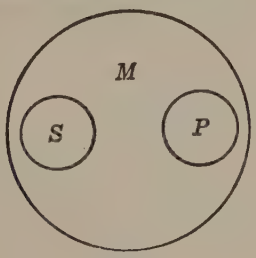

Fig. I.

It is evident that because the middle term is not distributed the minor term may be included in one part

of it while the major term is restricted to another part. Obviously then there is no warrant for making the leap which would be implied by predicating the major of the minor.

As a matter of fact "Parisians" are "Frenchmen" and the circle S *might* be altogether included within the circle P. This would give as possible the conclusion announced in the example; but possible conclusions are never logical inferences. In order to constitute reasoning at all the conditions set forth in the premises must be such as to *necessitate* the conclusion.

4. ILLICIT PROCESSES OF THE MINOR AND MAJOR. Rule 4 is violated when there is an improper distribution of either or both the terms of the conclusion. Enlarging the extension of a term for purposes of deduction is as unjustifiable as enlarging its meaning, and unless a term that is undistributed in its premise remains undistributed in the conclusion there will result a fallacy called in the case of the minor an *Illicit Process of the Minor,* and in the case of the major an *Illicit Process of the Major.* The following syllogism exemplifies an illicit process of the minor:

No bandits are law-abiding
All bandits are criminals
∴ No criminals are law-abiding.

The relation of terms as laid down in the premises may be symbolized by Fig. II.

The circle P might of course be altogether included in, or excluded from, the circle S; the statement of the premise leaves room for three possibilities; hence, although the conclusion is true as a matter of fact it

does not follow as a matter of inference. From the given premises we can draw only the particular negative, "Some criminals are not law-abiding."

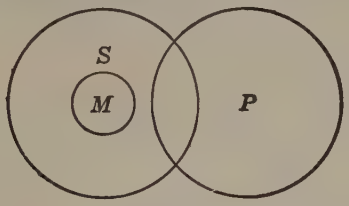

Fig. II.

An illicit process of the major is revealed in the following argument:

All novels are fiction
No biographies are novels
∴No biographies are fiction.

There are three possible ways of symbolizing the terms as related in the premises. Fig. III represents one way, according to which the conclusion should be "All biographies are fiction."

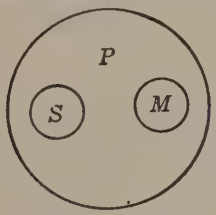

Fig. III.

Another way requires a diagram in which the circle P would intersect the circle S, permitting the conclusion "Some biographies are [or are not] fiction." Finally in order to get the conclusion originally stated it would be necessary to exhibit the total exclusion of S from P which includes M.

The fact that three propositions containing the

same matter might possibly be true while the premises are true, indicates that the terms as related in the premises do not furnish adequate grounds for inference; for there is no *necessary* implication where there is more than one implication.

5. Rule 5 would be violated by the use of two negative premises. The conditions resulting from such a procedure would make reasoning impossible from the start, for there is no hope of inferring anything about two given terms unless at least one of them is identified with some third term.

6. A violation of Rule 6 is opposed to the very nature of reasoning. First, a negative premise requires a negative conclusion; for granted that a common term is identical with one extreme and not identical with another, an affirmative relation between the extremes is out of the question. Second, a negative conclusion requires a negative premise; for one extreme could not be denied of another if both were affirmatively related to the common term in the given propositions.

7. Perhaps the simplest way of establishing the first corollary (otherwise Rule 7) is to indicate the fallacies that would result from every case of its violation. There are four possible combinations of particular premises, namely, II, OO, IO, and OI. No conclusion can be drawn when the given propositions are II, since two particular affirmatives exhibit no distribution and according to Rule 3, the middle term must be distributed at least once. The use of OO as premises would be a breach of Rule 5. Finally whether the combination is IO, or OI the conclusion (Rule 6) must be negative. Since however a negative conclusion distributes its predicate, the premises in

each case should provide for two distributed terms, the middle (Rule 3) and the major (Rule 4). As a matter of fact, they provide for only one distributed term; hence from such data there would result either an undistributed middle or an illicit process of the major.

8. The second corollary (otherwise Rule 8) may likewise be explained with reference to premises in which one proposition is particular. There are four possible cases: combinations of AI, AO, EI, EO. EO will yield no conclusion on account of its two negatives. AI provides for the distribution of the middle only, hence no term may be distributed in the conclusion. AO and EI each contain two distributed terms; one of these is of course the middle, and, since the conclusion is negative the other must be the major. The minor term is therefore undistributed in its premise and cannot be distributed in the conclusion.

QUESTIONS AND EXERCISES

1. Show how each of the rules of the syllogism can be derived from the *Dictum de Omni et Nullo.*
2. What is meant by a formal fallacy?
3. Explain and illustrate the fallacy called *Quaternio Terminorum.* By what other names is it known?
4. Explain and illustrate the fallacy of Illicit Middle.
5. Explain and illustrate an Illicit Process of the Major.
6. Explain and illustrate an Illicit Process of the Minor.
7. Show why a violation of Rule 5 would imply an absurdity from the start.
8. What impossible relations would be presumed by infractions of Rule 6?
9. What fallacies would result from violations of Rule 7, the first corollary?
10. What fallacies would result from violations of Rule 8, the second corollary?
11. Test the validity of the following arguments *first* by

showing whether they conform to the rules and *second* by noting whether Euler's Circles, representing the term relations of the premises, reveal the conclusion as necessary or merely possible. Before beginning your tests see that the propositions are arranged in the regular order of major premise, minor premise and conclusion.

(1) Some human acts are heroic
All legal acts are human
∴ Some legal acts are heroic.

(2) Because all trades are honorable and some vocations are not trades, therefore some vocations are not honorable.

(3) He holds these views, for only Socialists hold these views and he is a Socialist.

(4) He is a Socialist, because he holds these views and all Socialists hold these views.

(5) Poetry is elevating
All verse is not poetry
∴ Some verse is elevating.

(6) Some diseases are not curable, but all diseases need treatment, therefore some ailments that need treatment are not curable.

(7) He will not lie who does not fear
This man does not fear
∴ This man will not lie.

(8) No modern fiction is classic, yet some literature is classic, hence some modern fiction is not literature.

(9) Solomon was not wise, for all human beings are not wise and Solomon was a human being.

(10) Few newspapers are non-partisan, yet only non-partisan publications are fair, hence few newspapers are fair.

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CHAPTER XX

FIGURES AND MOODS OF THE SYLLOGISM

THE form of a syllogism has two determinants—Figure and Mood—and a statement of both is necessary for a complete description of it.

1. FIGURE. The figure of a syllogism is a characteristic imparted to its form by the arrangement of the terms. On account of the fact that the minor and major are always subject and predicate respectively of the conclusion, the variations in term-structure are limited to the premises. Consequently, it is found convenient to employ the term of comparison as a guide for locating the other two. For this reason a figure is usually said to be dependent on the position of the middle term. Four permutations are possible. first, the middle term may be subject of the major premise and predicate of the minor; second, it may be predicate of both; third, it may be subject of both; fourth, it may be predicate of the major and subject of the minor. These partial arrangements when properly filled out yield the Figures of the Syllogism as represented in the following scheme:

Figure I	Figure II	Figure III	Figure IV
M—P	P—M	M—P	P—M
S—M	S—M	M—S	M—S
S—P	S—P	S—P	S—P

2. MOOD. The mood of a syllogism is a characteristic imparted to its form by reason of the quantity and quality of the three component propositions. A mood is designated according to the letters which symbolize the major premise, the minor premise, and the conclusion in the order named; thus we speak of the mood AII, EAO, etc. It is usual to inquire what combinations of propositions with reference to their quantity and quality can furnish premises from which either A, E, I, or O may be inferred. The number of permutations based on uniting the four letters in pairs is sixteen, as may be seen from the following list of possible premises:

AA	EA	IA	OA
AE	EE	IE	OE
AI	EI	II	OI
AO	EO	IO	OO

Four of these forms—EE, EO, OE, OO—must be rejected as violations of Rule 5 which calls for at least one affirmative premise, and four—II, IO, OI, OO—as violations of the First Corollary which prohibits two particulars. Of these eight impossible combinations one—OO—is set down twice because it is a breach of both a rule and a corollary.

The partial mood IE can never be validly completed; an attempt to complete it would show an illicit process of the major. This is so, because the negative minor requires a negative conclusion (Rule 6) in which the predicate (the major term) is distributed; and secondly because the major premise, a particular affirmative, provides for no distribution whatever.

RELATIONS OF MOODS AND FIGURES. Of the six-

teen partial moods listed as possible, therefore, only eight are valid; namely, AA, AE, AO, EA, EI, IA, OA. It is usual to inquire in the next place how many of these moods can be validly employed as premises in the various figures. Each figure exhibits limitations of form which demand special conditions of quantity and quality in the component propositions. These conditions are set forth in what are sometimes called the Canons of the Four Figures. A statement of each of these canons will enable us to see how the validity of a mood depends upon the figure in which it appears.

CANON OF THE FIRST FIGURE

(1) *The minor premise must be affirmative.*
(2) *The major premise must be universal.*

Scheme of Figure I
M—P
S—M
S—P

(1) A negative minor would require an affirmative major (Rule 5) and a negative conclusion (Rule 6). But under such conditions the major term as predicate of the conclusion would be distributed and as predicate of its premise would be undistributed —a violation of Rule 4, or, more specifically, a fallacy of illicit process of the major.

(2) The middle term must be distributed. It is not distributed as predicate of the minor premise which must be affirmative; and it would not be distributed as subject of a particular major. Hence Rule 3 would be violated—fallacy of illicit middle —unless the major premise is universal.

Referring now to the eight valid moods and selecting combinations which conform to the Canon, we find that the first figure can take the following premises and conclusions: AAA, (AAI), EAE, (EAO), AII, EIO.

It will be seen that each of the partial moods AA, and EA yield two conclusions, a universal and a particular. When a universal proposition may be inferred but as a matter of fact a corresponding particular (its subalternate) is inferred the conclusion is said to be *weakened.* The two moods set off by parentheses in the preceding list show weakened conclusions.

CANON OF THE SECOND FIGURE

(1) *One of the premises must be negative.*
(2) *The major premise must be universal.*

Scheme of Figure II

P—M
S—M
S—P

(1) If both premises were affirmative, the middle term as predicate in each would be undistributed, and we should have a violation of Rule 3—fallacy of undistributed middle.

(2) Since one of the premises must be negative the conclusion must be negative, and a negative conclusion demands that provision be made for the distribution of the major term in its premise. But under the circumstances this can be done only by employing a major premise that is universal.

Selecting from the eight valid moods the combinations which conform to the present Canon, we find

that the second figure can support the following premises and conclusions: AEE, (AEO), AOO, EAE, (EAO), EIO. The moods in parentheses exhibit weakened conclusions.

CANON OF THE THIRD FIGURE

(1) *The minor premise must be affirmative.*
(2) *The conclusion must be particular.*

Scheme of Figure III

M—P
M—S
S—P

(1) A negative minor would require an affirmative major (Rule 5) and a negative conclusion (Rule 6). But in view of the undistributed major as predicate in its premise the assumed conditions would involve an illicit process of the major (Rule 4). The minor premise therefore must be affirmative.

(2) Since the minor is affirmative, its predicate, the minor term, is undistributed. If, however, the conclusion were universal the minor term as its subject would be distributed, and an illicit process of the minor (violation of Rule 4) would result.

The partial combinations which meet the requirements of this Canon are such that in the third figure we have the following premises and conclusions: AAI, AII, IAI, EAO, EIO, OAO.

CANON OF THE FOURTH FIGURE

(1) *If the major premise be affirmative the minor must be universal.*

(2) *If the minor be affirmative the conclusion must be particular.*

(3) *If either premise be negative the major must be universal.*

Scheme of Figure IV

P—M
M—S
S—P

(1) The middle term must be distributed. On the given assumption it is not distributed as predicate of the major, and on the further assumption of a particular minor it would be undistributed as subject in that premise. An affirmative major, then, demands a universal minor in order to avoid the fallacy of illicit middle (Rule 3).

(2) The position of the minor term is the same in the fourth figure as it is in the third; hence the reason which holds for a particular conclusion in the latter holds, on the given assumption, for a particular conclusion in the former.

(3) The major term is subject of its premise in the fourth figure as well as in the second; consequently if in the fourth figure a negative conclusion were necessary, an illicit process of the major could be prevented only by making the major premise universal.

The valid premises and conclusions of the fourth figure are: AAI, AEE, (AEO), IAI, EAO, EIO. The mood AEO contains a weakened conclusion.

THE REDUCTION OF "IMPERFECT" FIGURES

According to Aristotle the clearest and most direct way of demonstrating a conclusion is by means of the first figure. This is so because it is to this figure that the *Dictum de omni et nullo*—the fundamental axiom of syllogistic reasoning—has immediate and

obvious application. It would be a mistake to think that arguments presented in the other figures are less forceful; indeed, to bring out certain specific relations between terms they are more convincing. They are called "imperfect" as compared with the first or "perfect" figure for the sole reason that they do not show distinctly and at once the relation of logical whole to logical part and of both these to a given predicate.

The essential soundness and unitary character of reasoning can be seen from the fact that an argument expressed in one figure may be recast in any of the others without changing its inferential value. For example, the following syllogism in the first figure may be changed to the fourth by simply converting each premise:

No grafters are honorable
Some intelligent men are grafters
∴ Some intelligent men are not honorable.

In the fourth figure the syllogism would read:

No honorable men are grafters
Some grafters are intelligent
∴ Some intelligent men are not honorable.

The difference between the two syllogisms is perhaps more evident from their schemes:

First Figure	Fourth Figure
M e P	P e M
S i M	M i S
S o P	S o P

The process of rearranging terms in order to transform a syllogism from any figure into any other may be called "Reduction." As however, such structural

changes are most frequently made with a view of bringing arguments out of the imperfect figures into the first or perfect figure, the term Reduction has been narrowed in application to this specific rearrangement.

THE MNEMONIC LINES. The method of reducing syllogisms to the first figure has been simplified by a device commonly known as the Mnemonic Lines—a series of Latin verses composed of fictitious words that contain in cipher minute instructions with regard to rearranging the terms. The clearness with which this ingenious instrument correlates and in a sense unifies all the valid moods and figures gives it a peculiar importance. The Lines are as follows:

Barbara, Celarent, Darii, Ferioque *prioris;*
Cesare, Camestres, Festino, Baroco *secundae;*
Tertia Darapti, Disamis, Datisi, Felapton,
Bocardo, Ferison, *habet*. *Quarta insuper addit*:
Bramantip, Camenes, Dimaris, Fesapo, Fresison.

In these verses the words that are not italicized represent the valid moods of all the figures—weakened conclusions being omitted. Each of these words has three vowels which indicate the three component propositions in the usual order.

The initial consonants are limited to four—B, C, D, and F. In any line except the first the capital letter signifies that when the syllogism is reduced it will take the mood with which the letter is connected in the first line. For instance, Fesapo reduces to Ferio, Camestres to Celarent, etc.

Of the internal consonants six (*r, b, l, n, t, d*) have no significance, but each of the other four indicates a particular change which must be made in

the imperfect figure in order to reach the desired end, thus:

s (simple conversion) means that the proposition represented by the preceding vowel should be simply converted.

p (conversion *per accidens*) denotes that the proposition represented by the preceding vowel should be converted by limitation.

m (mutate) directs that the premises should be transposed, the original major and minor becoming respectively the new minor and major.

c (contradictory of the conclusion) signifies that reduction is to be performed *indirectly*, that is, by substituting for the premise preceding c the contradictory of the conclusion.

The three different procedures that the lines provide for have not the same importance: the change suggested by c occurs only twice; the transposition of premises called for by m is indicated in only five cases; whereas conversion—either simple (s) or by limitation (p)—is designated in every mood of the imperfect figures except Baroco and Bocardo. Knowing these facts the student should have little difficulty in reducing without the aid of the Mnemonic Lines.

We may now illustrate the application of s, p and m by examples. Let us first take a syllogism in the mood Felapton of the third figure:

E No Republicans are Democrats
A All Republicans are patriotic
O. ∴ Some patriotic citizens are not Democrats.

p indicates that the minor premise should be converted by limitation, F that the resultant mood will

be EIO as in Ferio. The argument as reduced would read:

E No Republicans are Democrats
I Some patriotic citizens are Republicans
O ∴Some patriotic citizens are not Democrats.

The schemes of the two syllogisms will exhibit the character of the change more clearly:

Third Figure	First Figure
M e P	M e P
M a S	S i M
S o P	S o P

For another illustration we may choose an argument in the mood Bramantip of the fourth figure.

A All moths are insects
A All insects are invertebrate
I ∴ Some invertebrates are moths.

B, m and p are the significant letters in Bramantip. B means that the new mood will be AAA, as in Barbara; m calls for a mutation of the premises; and p indicates that the conclusion should be converted, as it were, by limitation. The syllogism in the first figure will read:

A All insects are invertebrate
A All moths are insects
A. ∴All moths are invertebrate.

The structural difference may be brought out more distinctly by the schemes:

Fourth Figure	First Figure
P a M	M a S
M a S	P a M
S i P	P a S

It is noticeable that the argument as reduced has the original minor term as its major and the original major term as its minor. The same change will occur whenever the premises are transposed; consequently the words that contain m always end in a letter which calls for conversion of the conclusion. Only in Bramantip, however, is the conclusion "converted by limitation," for in this mood a simple conversion would leave the new conclusion weakened.

INDIRECT REDUCTION. Indirect reduction is a method of proving the validity of an imperfect figure by showing that the conclusion of a corresponding syllogism in the first figure contradicts one of the given premises. The essential process is to substitute for one of these premises the contradictory of the original conclusion, and then to draw a new inference. This inference in which the middle term appears as one of the extremes will always be the contradictory of the premise for which substitution has been made. The method of indirect reduction is familiar to students of geometry as the *Reductio ad absurdum;* it is also known as *Reductio per impossibile.*

Let us now consider the indirect reduction of the following syllogism in Baroco:

A All oratory is persuasive
O Some speeches are not persuasive
O. ∴. Some speeches are not oratory.

If the foregoing conclusion cannot be inferred from the accepted p emises its contradictory, "All speeches are oratory" must follow. Our problem is to prove that this contradictory does not follow by showing the absurd consequences of dealing with it

as acceptable—using it, for instance, as a premise in another syllogism. The initial letter of Baroco signifies that the reduced syllogism will have the mood of Barbara and the letter c indicates that the contradictory of the conclusion should be substituted for the minor premise. Taking the original major in connection with the new minor we may draw a valid conclusion and our argument will read:

A All oratory is persuasive
A All speeches are oratory
A. ∴. All speeches are persuasive.

Now although the proposition "All speeches are persuasive" is a legitimate inference from the new premises it is manifestly false because it contradicts the original minor which was given as true. But this inconsistency needs to be explained. The fault does not lie with the original major, for it also was given as true. Hence the only possible source of error is the minor premise of Barbara, that is, the contradictory of the original conclusion. This minor must be false, otherwise we should not be forced into the absurdity of inferring the contradictory of the minor in Baroco. But if the supplied minor is false, the original conclusion must be true.

It can be proved in a similar way that unless Bocardo is regarded as yielding a valid inference the conclusion arrived at by means of the reduced syllogism in Barbara will contradict the original major premise. To show by further illustration that the other imperfect figures are subject to treatment by indirect reduction is hardly necessary; nevertheless it will be useful to bear the fact in mind.

Direct reduction of Baroco and Bocardo can be

effected by employing obversion and contraposition in addition to conversion. We have seen that the Mnemonic Lines as traditionally handed down make provision for the use of no process of immediate inference except conversion. Some logicians, however, in order to show that all the imperfect figures may be reduced directly, have suggested as substitutes for Baroco and Bocardo the words Faksoko and Doksamosk, in which k signifies obversion, ks partial contraposition, and sk obversion of the converse of the new conclusion. To illustrate the manner of working with processes other than conversion let us apply Doksamosk to the following syllogism:

O Some cattle are not horned
A All cattle are ruminants
O.·. Some ruminants are not horned.

Mutating the premises and contrapositing the major as directed we obtain this argument in Darii:

A All cattle are ruminants
I Some non-horned animals are cattle
I.·. Some non-horned animals are ruminants.

Finally by obverting the converse of this conclusion in I we are brought back to the original conclusion in O. Perhaps the schemes would make the steps of reduction clearer. [A line over S and P ($\bar{S}$, $\bar{P}$) symbolizes the contradictory of these terms, that is, non-S and non-P].

Third Figure		First Figure
M o P	M a S	Original minor
M a S	$\bar{P}$ i M	Contrapositive of major
S o P	$\bar{P}$ i S	
	S i $\bar{P}$	Converse of new conclusion
	S o P	Obverse of preceding

QUESTIONS AND EXERCISES

1. Define the figure of a syllogism.
2. Set forth the scheme of each figure.
3. Define the mood of a syllogism.
4. How is a mood symbolized?
5. Show that of the sixteen possible premises all but eight violate one or more of the general rules.
6. Explain why the partial mood IE can never be completed.
7. State and prove the canon of each of the four figures.
8. Are arguments expressed in any of the "imperfect" figures less cogent than those expressed in the first? Why are the imperfect figures so called?
9. Define Reduction. May certain arguments in any figure be reduced to arguments in any other figure?
10. Reduce an argument in EIO of the First Figure to a mood of the Second Figure.
11. How is the term "Reduction" usually restricted?
12. Explain the cipher of the Mnemonic Lines.
13. Apply the directions given in the Lines to the reduction of Cesare and Festino of the Second, Darapti and Ferison of the Third, Camenes and Fesapo of the Fourth.
14. Define Indirect Reduction.
15. Explain the process of reducing indirectly.
16. May any figure, including the First, be reduced indirectly to some other figure? Answer this question by applying indirect reduction to AAA of the First, AEE of the Second, EAO of the Third, AAI of the Fourth.
17. Reduce AOO of the Second and OAO of the Third directly.

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CHAPTER XXI

HYPOTHETICAL AND DISJUNCTIVE SYLLOGISMS

I. HYPOTHETICAL ARGUMENTS

IN accordance with our general division of the syllogism we have next to consider the Pure and Mixed Hypothetical forms. As we have seen, pure hypothetical reasoning is composed of three *"If"* judgments, whereas in the mixed hypothetical only the major premise is conditional.

1. THE PURE HYPOTHETICAL. This form of mediate inference may be treated like the ordinary categorical syllogism. Each of its propositions is reducible to the categorical type and we may thus speak of its moods and figures. Its validity may be estimated by applying the common rules and when it takes one of the imperfect figures it may be rearranged to conform to the first figure.

The following illustrations set forth, first, the scheme of the argument; second, an actual example and its mood; and third, in the case of the imperfect figures, the example in its reduced mood.

A. Pure Hypothetical of the First Figure.

If A then B	or	If any S is X that S is P
If C then A	or	If any S is M that S is X
∴ If C then B.	or. ∴	If any S is M that S is P.

If a man is meek he is blessed
If a man is poor in spirit he is meek
∴ If a man is poor in spirit he is blessed.

B. An Example Corresponding to Cesare of the Second Figure.

If B then not A	or	If any S is P it is not X
If C then A	or	If any S is M it is X
∴ If C then not B.	or	∴ If any S is M it is not P.

If a work of art is beautiful it is not degrading
If a work of art is sensual it is degrading
∴ If a work of art is sensual it is not beautiful.

Reduced to Celarent

If a work of art is degrading it is not beautiful
If a work of art is sensual it is degrading
∴ If a work of art is sensual it is not beautiful.

C. An Example Corresponding to Felapton of the Third Figure.

If A then not B	or	If any S is X it is not P
If A then C	or	If any S is X it is M
∴ Sometimes if C then B	or	∴ Sometimes if S is M it is not P.

If an animal is a lizard it is not warm-blooded
If an animal is a lizard it is a quadruped
∴ Sometimes if an animal is a quadruped it is not warm-blooded.

Reduced to Ferio

If an animal is a lizard it is not warm-blooded
Sometimes if an animal is a quadruped it is a lizard
∴ Sometimes if an animal is a quadruped it is not warm-blooded.

D. An Example Corresponding to Bramantip of the Fourth Figure.

If B then A	or	If any S is P that S is X
If A then C	or	If any S is X that S is M
∴ Sometimes if C then B.	or	∴ Sometimes if S is M it is P.

If a stamp is rare it is a curiosity
If a stamp is a curiosity it is worth keeping
∴ Sometimes if a stamp is worth keeping it is rare.

Reduced to Barbara

If a stamp is a curiosity it is worth keeping
If a stamp is rare it is a curiosity
∴ If a stamp is rare it is worth keeping.

2. THE MIXED HYPOTHETICAL. Pure hypothetical reasoning never goes beyond the limits of conjecture. Its conclusions are always problamatic even if validly drawn. On the other hand, the mixed hypothetical settles a point quite definitely. Its major premise, like the categorical major, states a general truth which in the minor premise is applied directly to a particular case. The antecedent of the major lays down a condition upon which the consequent necessarily depends, and whenever this condition is fulfilled the consequent follows as a matter of course. Generally, however, the given antecedent is not the only one with which the consequent is necessarily connected, and on this fact the rule for hypothetical reasoning is based. The subjoined example makes it clear that an occurrence which may be broadly described as the destruction of a house, can have several antecedents. In using the illustration we do not intend to support the doctrine of the Plurality of Causes; the "destruction" is really a different effect in each instance.

If the waves swept it
If the tornado hit it
If it was dynamited
If fire gutted it
If it was not well guarded
} the house is destroyed.

Now when any of the foregoing antecedents is fulfilled we may infer that "the house is destroyed"; yet if it were first stated that "the house is destroyed" we

could not say which of the various antecedents preceded the destruction. Similarly the assertion that "the house is not destroyed," would lead to the inference that none of the antecedents was fulfilled; but the assertion that a particular antecedent is not fulfilled would lead to no conclusion whatever. Hypothetical reasoning then is subject to the following Rule: *Place the antecedent or remove the consequent.*

The use of the words "place" (or "posit") and "remove" (or "sublate") instead of "affirm" and "deny" will avoid possible ambiguity; for the direction "to affirm" a negative proposition might convey the idea of restating it in an affirmative form, and the direction "to deny" a negative, the idea of restating it in its original negative form; whereas in the meaning of the rule to affirm a negative proposition is to restate it in its original negative form, and to deny a negative proposition is to change it to the affirmative form. For instance we affirm "He is not honest" by merely restating the proposition and we deny "He is not honest" by declaring "He is honest."

There is one exception to the rule, namely, when the antecedent is the sole condition on which the consequent depends. Then a conclusion is valid whether the antecedent or consequent is "placed" or removed."

It should be noted also that when in the minor the consequent is "removed" the contradictory, not the contrary, of the antecedent should be "placed" in the conclusion. Thus:

If all men were just, courts could be abolished
But courts could not be abolished
∴ Some men are not just.

The proposition "No men are just" would be more than a simple denial of the antecedent.

MOODS OF THE MIXED HYPOTHETICAL. Reasoning by means of a conditional major premise may take two forms: the one, the *Modus Ponens* or Constructive type, in which the minor premise "places" the antecedent and the conclusion "places" the consequent; the other, the *Modus Tollens* or Destructive type, in which the minor "removes" the antecedent. In each mood there are four variations, the schemes of which are as follows:

The Modus Ponens

(1) If A then B; but A; therefore B.
(2) If A then not B; but A; therefore not B.
(3) If not A then B; but not A; therefore B.
(4) If not A then not B; but not A; therefore not B.

The Modus Tollens

(1) If A then B; but not B; therefore not A.
(2) If A then not B; but B; therefore not A.
(3) If not A then B; but not B; therefore A.
(4) If not A then not B; but B; therefore A.

REDUCTION OF MOODS. It is possible to transpose a variation of the Modus Ponens into any variation of the Modus Tollens and vice versa. Reduction of this sort involves the treatment of the hypothetical premise by contraposition or conversion in the manner we have already explained (p. 168). Thus, using an example with which we are familiar, we may transpose the fourth variation of the *Modus Tollens* into the first variation of the *Modus Ponens:*

If the house is not destroyed it was not dynamited
But it was dynamited
∴ It is destroyed.

In order to arrive at the full contrapositive of the major we first obvert it to "If the house is not destroyed

it is not the case that it was dynamited"; then convert this result to: "If the house was dynamited it is not the case that it is not destroyed; and finally obvert this partial contrapositive to: "If the house was dynamited it is destroyed." The last proposition, the full contrapositive, will be the major of the new argument, which will then read:

If the house was dynamited it is destroyed
But it was dynamited
∴ It is destroyed.

Or schematically

(a) If not A then not B
But B
Therefore A.

(b) If B then A (full contrapositive of preceding major)
But B
Therefore A.

REDUCTION TO CATEGORICAL FORMS. Inasmuch as some conditional propositions lend themselves easily to categorical expression the mixed hypothetical syllogism may at times be reduced without any awkwardness to one of the valid moods of the categorical. This is especially the case when the major *"If"* judgment is of the *first form,* that is, when it interprets an expository universal (p. 166). Thus the following argument:

If an animal does not cook it is not a man
Apes do not cook
∴ Apes are not men.

may be reduced to Celarent of the first figure:

No animals that do not cook are men
Apes do not cook
∴ Apes are not men.

However, when the major premise of the mixed syllogism is of the *second form,* the result of reduction is as a rule verbally awkward and almost impossible to reproduce in thought. For instance, "If it thunders the milk will sour" would be rendered categorically by "The case of its thundering is a case of the milk turning sour," a proposition which as the expression of a relation between two concepts leaves something to be desired.

FALLACIES OF THE MIXED HYPOTHETICAL. The two formal errors peculiar to this kind of reasoning occur when the minor premise "places" the consequent or "removes" the antecedent. "Placing" the consequent is analogous to a fallacy of illicit middle, and "removing" the antecedent to a fallacy of illicit major; for if a false hypothetical syllogism is reduced to categorical form either the middle term will not be distributed at all, or the major term will be distributed in the conclusion and not in its premise.

II. THE DISJUNCTIVE SYLLOGISM

In this form of reasoning the major premise is a disjunctive proposition and the minor a categorical which "places" or "removes" one (or more) but not all of the alternatives. Before proceeding with a disjunctive argument we should ascertain whether the alternatives are intended to be mutually exclusive or not. It is probable that in most instances the major premise has a strict disjunctive purpose; yet this is not always the case (p. 177), and when we have a reasonable doubt about the exclusive character of the alternatives we should adopt the interpretation which requires the least assumption and look upon them as possibly true together. To adopt this interpretation

will, as we shall see, restrict the freedom with which conclusions may be drawn. But even if the fuller assumption seems admissible the right to infer will be limited unless the members of the disjunction are exhaustive as well as exclusive.

A. When the purpose of argumentation is strictly disjunctive, that is, when only one alternative can be true, there are two forms of the syllogism, as illustrated in the following schemes:

Modus Ponendo Tollens	Modus Tollendo Ponens
A is either B or C	A is either B or C
It is B	It is not B
∴ It is not C.	∴ It is C.

The conclusion of the *Modus Ponendo Tollens* is always negative in function, though it may not be so in form; in other words, it invariably "removes" all that the minor premise fails to "place"; on the contrary, the conclusion of the *Modus Tollendo Ponens* is affirmative in function, because it "places" what the minor does not "remove."

It should be noted that the *Modus Tollendo Ponens* will yield no conclusion unless the disjunction is complete. Take, for example, the following syllogism:

A man is either white, black, yellow or red
This man is neither white, black nor yellow
∴ This man is red.

The inference is invalid because the disjunction is incomplete—the man may be brown. The *Modus Ponendo Tollens* is not subject to this limitation; for if one alternative is "placed," the others must be "removed." Hence, to the assumption of mutual exclusion in case (a) there must be added for the valid em-

ployment of the *Modus Tollendo Ponens* the assumption that the disjunction is complete.

B. When on the other hand the purpose of reasoning is not strictly disjunctive the *Modus Ponendo Tollens* will yield no valid inference; for to "place" one of several alternatives, all of which may be possibly true, is to give no ground for stating anything about the rest. If, however, one (or more) but not all of the alternatives be "removed" we are obliged to "place" the remaining member (or members). For instance, granted "The plea is either subtle or righteous or persuasive, or perhaps all three" we may not by asserting that it is "subtle" deprive it of the other two attributes; but a denial of its "subtlety" will compel us to assert that it is "either righteous or persuasive."

FALLACIES OF THE DISJUNCTIVE. A formal fallacy in this sort of reasoning cannot occur unless the minor premise and the conclusion should both "place" and both "remove" different alternatives. Such an error could hardly happen except through inadvertence, yet the following example has been known to puzzle beginners:

Either it rains or it does not rain
It rains
∴ It does not rain

Material fallacies, on the other hand, need to be carefully guarded against, and to this end the limitations already noted with regard to the use of the two moods should be kept in mind. In every case of disjunctive reasoning the purpose of the argument ought to be ascertained; then if it is decided that the alternatives are mutually exclusive the *Modus Tollendo*

Ponens should not be used unless the disjunction is complete: or if it is seen that all the alternatives may possibly be true at the same time the *Modus Ponendo Tollens* should not be employed at all.

REDUCTION. The manner of expressing disjunctive propositions in hypothetical form has already been discussed (p. 177). Here then we need only mention that, provided all the possibilities are expressly or presumably exhausted, a disjunctive argument may be reduced to a hypothetical syllogism by simply changing the major premise into a hypothetical proposition. The hypothetical syllogism thus obtained may itself be reduced to categorical form by the method described on page 222.

Perhaps it might be helpful to point out that the presence of a disjunctive proposition does not always give the argument a disjunctive character. The following form, for instance, is obviously categorical:

A is either B or C
E is A
∴ E is either B or C.

In this example the minor premise neither "places" or "removes" an alternative and therefore the purpose of the argument is not disjunctive.

III. THE DILEMMA

A dilemma is a syllogism which has for its major premise a compound hypothetical and for its minor a disjunctive. Strict usage would confine dilemmatic reasoning to cases in which only two alternatives are presented and would employ the terms "trilemma," "tetralemma" and "polylemma" to designate the forms which offer respectively three, four or many al-

ternatives. The term "dilemma," however, is now generally applied, as in our definition, to all arguments that force an adversary to choose between two or more alternatives either or all of which will embarrass him. By the very nature of this sort of reasoning the members of the disjunction are assumed not only to be mutually exclusive but also to exhaust the possibilities.

STRUCTURE OF THE DILEMMA. The dilemma is really a mixed hypothetical syllogism, with a compound major premise. Its disjunctive minor, then, either "places" alternative antecedents or "removes" alternative consequents. Corresponding to the *Modus Ponens* and the *Modus Tollens* of the mixed hypothetical there are two types of the dilemma, the Constructive, a result of "placing" disjoined antecedents, and the Destructive, a result of "removing" disjoined consequents. Accordingly a Constructive Dilemma must carry at least two antecedents and a Destructive at least two consequents. Each type has a simple and a complex form: the Constructive Dilemma is simple when it has the same consequent throughout, and complex when it has two or more consequents: the Destructive Dilemma is simple when only one antecedent conditions the consequents, and complex when there are two or more antecedents.

We may symbolize the structure of these various forms by means of the following schemes:

(1) The simple constructive
If A is B, E is F; and if C is D, E is F
Either A is B or C is D
∴ E is F.

(2) The complex constructive
If A is B, E is F; and if C is D, G is H
Either A is B or C is D
∴ Either E is F or G is H.

(3) If A is B then both C is D and E is F
Either C is not D or E is not F
∴ A is not B.
(4) If A is B, E is F; and if C is D, G is H
Either E is not F or G is not H
∴ Either A is not B or C is not D.

The following examples will show how the preceding forms may be filled out:

(1) Simple Constructive
If the official resigns he will hurt his party and if he does not resign he will hurt his party
But he will either resign or not
∴ He will hurt his party
(2) Complex Constructive
If an operation is performed the patient will die of shock and if an operation is not performed he will die of exhaustion
But an operation will either be performed or not
∴ The patient will either die of shock or die of exhaustion.
(3) Simple Destructive
If this witness is to be believed he must be both competent and honest
But he is either not competent or not honest
∴ He is not to be believed.
(4) Complex Destructive
If your education is broad you have read everything, and if you are virtuous you have not read immoral literature
But either you have not read everything or you have read immoral literature
∴ Either your education is not broad or you are not virtuous.

In all the preceding arguments the minor premise offers a choice of alternatives. There are syllogisms, however, in which, though the minor is not disjunctive, the conclusion seems to embarrass an opponent and thus serves the purpose of dilemmatic reasoning. Such forms deviate from the definition we have adopted, but since they are called dilemmas by some logicians

we may profitably note their distinctive structure. The following example bears a close resemblance to the Simple Destructive type:

> If you would not starve you must either beg or work
> But you can neither beg nor work
> ∴ You must starve.

In this syllogism the minor premise is not a disjunctive but a conjunctive denial of the alternatives (p. 178). In the typical Simple Destructive the consequents must be conjoined in the major and denied disjunctively in the minor. Were they offered disjunctively in the hypothetical the denial of one or the other in the minor would not necessarily deny the antecedent.

METHODS OF REPLYING TO THE DILEMMA. There are three ways of dealing with this form of argument: (A) "taking it by the horns," (B) "escaping between the horns," and (C) offering a dilemma in rebuttal.

A. It is often advisable to reflect carefully on the character of the connection between antecedent and consequent in the major premise. The connection may not be necessary, and to point this out in the case of even one alternative would disconcert an opponent. Thus in our example of the Complex Destructive type it could be shown that to be broadly educated does not imply the reading of everything. The value of this method of attack lies in its directness and it has been well described as "taking the dilemma by the horns."

B. We have seen that dilemmatic reasoning is based on the assumption that the alternatives named in the major represent a complete disjunction. If then in any case it can be shown that this assumption

is not warranted, that in other words all the possibilities have not been considered, the "choice of evils" which the argument intends to impose is successfully avoided. Thus in one of our examples the major premise, "If you would not starve you must either beg or work," omits the possibility of relief through voluntary charity. To detect this omission would enable the victim of the argument to "escape between the horns."

C. Even in the case of a defective dilemma there seems to be something in the structure of the syllogism which lends it a fictitious force. This fact puts the dilemma in high favor with a certain class of rhetoricians; but logicians are extremely cautious in using the form on account of the ease with which material fallacies tend to creep into the premises. Frequently, however, the argument that aims to compel a choice of alternatives may prove a boomerang, that is, by skilful manipulation on the part of the "victim" it may be turned back against its author. This method of parrying the dilemma is known as rebuttal.

REBUTTAL OF SIMPLE DILEMMAS. In order to rebut a simple dilemma it is often, though not always, necessary to employ entirely new premises to establish a denial of the original inference. For instance, our example of a Simple Constructive may be replied to in this way:

> If the official fights the case he will not hurt his party, and
> if he does not fight the case he will not hurt his party
> But he will either fight the case or not
> ∴ He will not hurt his party.

It would seem that the Simple Destructive Dilemma cannot be successfully rebutted by any argument

which would conform to our definition. However, in order to put a question back upon a plane of more direct discussion, a retort that lacks the features of a rebuttal may be offered by means of the form we have already referred to as resembling the Simple Destructive type; thus our example may be dealt with in the following way:

If this witness is not to be believed he must be either incompetent or dishonest
But he is neither incompetent nor dishonest
∴ He is to be believed.

REBUTTAL OF COMPLEX DILEMMAS. Rebuttal is peculiarly impressive when applied to a complex dilemma because then it can be built up by a mere manipulation of the given material. In the case of the Complex Constructive the method of reply calls for transposition and denial of the consequents, and in the case of the Complex Destructive transposition and denial of the antecedents. These directions applied to our example of a Complex Constructive would give us the following rebuttal:

If an operation is performed the patient will not die of exhaustion and if an operation is not performed he will not die of shock
But an operation will either be performed or not
∴ The patient will either not die of exhaustion or not die of shock.

Our example of the Complex Destructive may be answered thus:

If I am not virtuous I have read everything, and if my education is not broad I have not read immoral literature
But either I have not read everything or I have read immoral literature
∴ Either I am virtuous or my education is broad.

QUESTIONS AND EXERCISES

1. What is a Pure Hypothetical Syllogism and how should it be treated?

2. Construct an original pure hypothetical argument corresponding to the mood Camestres of the Second Figure and reduce it to the First.

3. Define a Mixed Hypothetical Syllogism.

4. State the rule for valid reasoning in the mixed hypothetcial form.

5. What is the exception to this rule?

6. When a consequent is "removed" should the contradictory or the contrary of the antecedent be "placed" in the conclusion? Give a reason for your answer.

7. Give the schemes of the four variations of the *Modus Ponens*, the Constructive type of the mixed hypothetical.

8. Give the schemes of the four variations of the *Modus Tollens*, the Destructive type.

9. Reduce the following argument in the Fourth form of the *Modus Ponens* to the First form of the *Modus Tollens*: If the powder was not ignited it did not explode; but it was not ignited; therefore it did not explode.

10. Reduce the following argument from the *Modus Ponens* to the *Modus Tollens* and name the form in each mood: If she cried, her eyes are not dry; but she cried; therefore here eyes are not dry.

11. Criticize the following arguments:

(1) Suppose a figure is a triangle, it is three-sided
This figure is three-sided
∴ This figure is a triangle.

(2) If thieves did not enter, the money is still there
But the money is still there
Hence thieves did not enter.

(3) This law is not unjust; for on the assumption that a law is unjust it is ignored, and this law is not ignored.

(4) If a being laughs that being is a man; consequently this being is not a man, for it does not laugh.

(5) When the wind is from the east the weather is cool; but the weather is cool, so the wind is from the east.

(6) If a book is vulgar it is harmful; but this book is not vulgar, hence it isn't harmful.

(7) Unless a man is kind he is little better than a brute; this man is little better than a brute, for he is not kind.

(8) Ted isn't eligible; for only on condition that a candidate has good class-standing is he eligible, and Ted's class-standing is wretched.

(9) If heads turned you would have won; but heads didn't turn, so you lost.

12. Reduce the foregoing arguments to categorical syllogisms; state the mood and figure and in a case of invalid reasoning name the fallacy.

13. Describe the Disjunctive Syllogism.

14. What reasons are there for saying that sometimes at least the major premise of a disjunctive argument carries the strict disjunctive purpose?

15. Name the two moods of the disjunctive syllogism that may be employed when the purpose is strictly disjunctive. Give the scheme of each.

16. Show by an example that the *Modus Tollendo Ponens* will yield no conclusion unless the disjunction is complete.

17. Show that when the purpose of reasoning is not strictly disjunctive the *Modus Ponendo Tollens* will yield no valid inference.

18. Criticize the following arguments, naming their mood. Bear in mind that in some cases the reasoning need not reveal a strictly disjunctive purpose and that a disjunction need not always be complete.

(1) He is either a physician or a surgeon
He is a surgeon
∴ He is not a physician.

(2) A proposition is either categorical, hypothetical, or disjunctive; but this proposition is disjunctive; hence it is neither categorical nor hypothetical.

(3) Either miracles have occurred or, with few exceptions, the wisest men of all times have been duped; but it is unreasonable to say that in general the wisest men of all times have been duped; accordingly it is reasonable to assert that miracles have occurred.

(4) Either Patrick or Timothy went to market, and as it is certain that Patrick went, Timothy did not go.

(5) The incident happened either at the middle or towards the end of the play: it didn't happen towards the end; consequently it happened at the middle.

(6) Either the Pope is infallible or the deposit of faith has no safeguard; but the deposit of faith must have a safeguard; therefore the Pope is infallible.

(7) A North American is either a citizen of Mexico or of the United States; but this man is a citizen of Mexico; hence he is not a citizen of the United States.

(8) A soldier is either a private or an officer; but this man is a soldier; therefore he is either a private or an officer.

19. Reduce arguments (3) and (6) of the preceding question to hypothetical syllogisms.

20. Define a Dilemma.

21. Distinguish between a Constructive and a Destructive dilemma.

22. What is the difference between the Simple and Complex constructive types and the Simple and Complex destructive types?

23. Give the scheme of each of the four forms.

24. Name and describe the three methods of replying to a dilemma.

25. In what form are the following arguments cast? Criticize them.

(1) If writing is literature it will elevate the mind and the heart
But some writing either does not elevate the mind or does not elevate the heart.
Hence some writing is not literature.

(2) If you are selfish you will be shunned and if you are not selfish you will be imposed upon; but you must be either selfish or not; therefore you will be either shunned or imposed upon.

(3) If I tell the truth I'll be punished and if I tell a lie I'll be punished; but I must either tell the truth or tell a lie; accordingly I shall be punished.

(4) If he expects to live he will diet and if he hopes to be happy he will eat what he likes; but either he will not diet or he will not eat what he likes; hence either he does not expect to live or he does not hope to be happy.

26. Rebut each of the preceding dilemmas. Also rebut the following classical examples:

(1) If you act justly men will hate you and if you act unjustly the gods will hate you; but you must act either justly or unjustly; therefore you will be hated.

(2) If you win the case you must pay according to our agreement and if you lose it you must pay by order of the court; but you will either win or lose the case; hence you must pay.

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CHAPTER XXII

IRREGULAR ARGUMENTS AND EXTRA-SYLLOGISTIC FORMS

I. THE ENTHYMEME

IN any ordinary interchange of ideas much is left to be understood. Indeed it may be said that language is the *abbreviated* expression of thought. Written as well as oral speech is full of elisions not only of words but of judgments. It is common enough, therefore, to meet with syllogisms in which one of the constituent propositions has been dropped. When this is the case the syllogism is called an Enthymeme. It is referred to as an Enthymeme of the First Order when the major premise is omitted, of the Second Order when the minor premise is omitted, and of the Third Order when the conclusion is omitted. By dropping in turn each of the component judgments in the following syllogism we may exemplify the three orders:

Complete Argument	All prophets are wise He is a prophet ∴ He is wise.
Enthymeme of the First Order	He is a prophet ∴ He is wise.
Enthymeme of the Second Order	All prophets are wise ∴ He is wise.
Enthymeme of the Third Order	All prophets are wise He is a prophet.

Enthymemes are not confined to categorical syllogisms, and it is easy to recognize an abbreviated mixed hypothetical or mixed disjunctive of the second

or third order. Hypothetical and disjunctive enthymemes of the first order are somewhat more difficult to place. When, however, we come upon two propositions which evidently bear the relation of premises and conclusion but in which there is no common term, we may decide that we are dealing with a mixed hypothetical or a mixed disjunctive. For instance, the enthymeme "The ground is wet because rain has fallen" may be completed as one or the other of the following mixed syllogisms:

Hypothetical	or	Disjunctive
If rain has fallen the ground is wet		Either the ground is wet or rain has not fallen
Rain has fallen		Rain has fallen
∴ The ground is wet.		∴ The ground is wet.

II. THE POLYSYLLOGISM

Since an inference is not always acceptable merely because it is validly drawn there may be need on occasion to offer proof of data which might otherwise seem gratuitous. It sometimes happens then that an argument may be fused with a supporting syllogism in such a way that the conclusion of the latter is seen to be a premise of the former. Two or more syllogisms dovetailed in this manner constitute what is called a Polysyllogism or Chain of Reasoning. It is to be noted that even in a long series, the arguments are definitely related in pairs; in other words, any syllogism either supports or is supported by the syllogism adjacent to it. In such related pairs the supporting argument is called a Prosyllogism, the other an Episyllogism. Hence *a Prosyllogism is one that has for its conclusion a premise of another argument; an Episyllogism one which takes for a premise the conclusion of another argument.*

The *Dictum de Omni et Nullo* is of course applicable to a polysyllogism; for whatever is affirmed or denied of a logical whole may be affirmed or denied of any of its parts, whether the part in question is a result of one division or of repeated subdivisions. In a chain of reasoning, no matter how long, the terms bear the relation of a part and its subdivisions to a whole and of all these to a given predicate. To show that this is true in the case of single pairs of blended arguments, let us diagram the term-relations of two polysyllogisms in one of which (A) the prosyllogism supports the major premise, in the other of which (B) it supports the minor premise.

(A)

Prosyllogism supporting the major premise

All educated men are respected
All professional men are educated
∴ All professional men are respected
All physicians are professional men
∴ All physicians are respected.

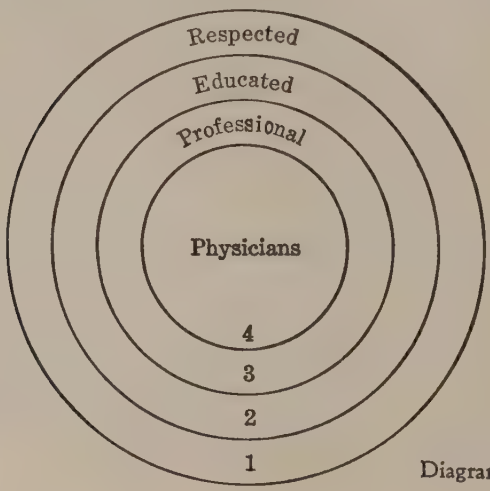


Diagram of (A)

(B)

Prosyllogism supporting the minor premises

All snakes are reptiles
Cobras are snakes
∴ Cobras are reptiles.

All reptiles are repulsive
Cobras are reptiles
∴ Cobras are repulsive.

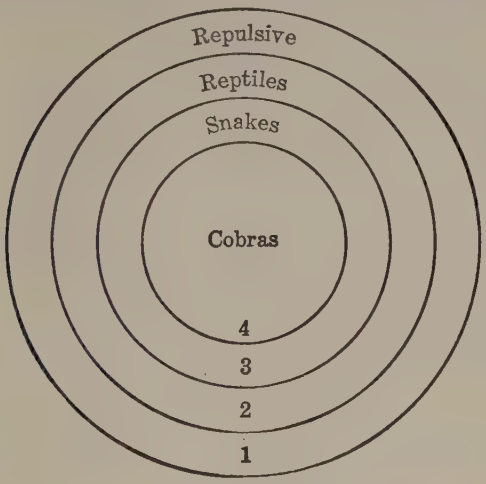


Diagram of (B)

In accordance with the Dictum, Circle 1 in both diagrams represents a general predicate affirmed of a logical whole (Circle 2) and therefore affirmable of a part derived by division (Circle 3) and a part derived by subdivision (Circle 4). Attention should be called to the fact that every pair of conjoined syllogisms contains only four terms; and in a longer chain of reasoning it will be found that the number of terms will always be two more than the number of conjoined syllogisms.

PROGRESSIVE AND REGRESSIVE REASONING. The advance of thought in a chain of mediate inferences may be from the supporting syllogism to the argu-

ment it supports or from the latter to the former. When the direction of proof is from the prosyllogism to the episyllogism, when in other words each successive syllogism of a series has for its conclusion a premise of the syllogism which follows, the reasoning is said to be Progressive or Synthetic; when on the other hand the advance is from the episyllogism to the prosyllogism, that is, when each successive syllogism has for a premise the conclusion of the syllogism which follows, the reasoning is called Regressive or Analytic.

The two polysyllogisms diagrammed in the foregoing figures are of the Progressive type; the Regressive form may be illustrated as follows:

Episyllogism— All virtues are ennobling
Humility is a virtue
∴ Humility is ennobling.

Prosyllogism— Humility is a virtue, *because*
It is a habit of doing good,
and
All habits of doing good are virtues.

In the preceding examples of the polysyllogism every proposition of the conjoined arguments was expressed. There are cases, however, in which this is not so, in which, consequently, the enthymeme plays a part. Thus, *a progressive polysyllogism with some of the propositions suppressed is called a Sorites; a regressive polysyllogism with at least one of the propositions omitted is called an Epicheirema.*

III. THE SORITES

Inasmuch as a sorites is always progressive, the advance in thought is from prosyllogism to episyllogism.

The arguments that serve as prosyllogisms may support either the major or the minor premise of the succeeding syllogism—a distinction we are already familiar with in the case of Polysyllogisms (A) and (B) diagrammed on a preceding page. Accordingly there are two kinds of sorites: (A) the Goclenian, in which each complete prosyllogism proves the subsequent major premise; and (B) the Aristotelian in which each complete prosyllogism proves the subsequent minor.

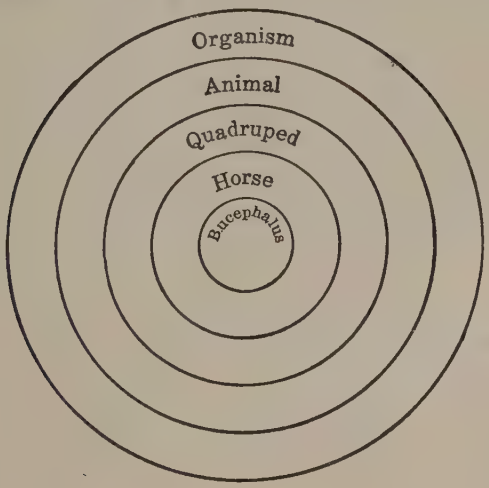
The following classic examples illustrate both forms:

(A) *Goclenian Sorites*
(majors of episyllogisms proved)

An animal is an organism
A quadruped is an animal
A horse is a quadruped
Bucephalus is a horse
∴ Bucephalus is an organism.

(B) *Aristotelian Sorites*
(minors of episyllogisms proved)

Bucephalus is a horse
A horse is a quadruped
A quadruped is an animal
An animal is an organism
∴ Bucephalus is an organism



In order to emphasize the similarity of these two chains of reasoning a diagram, as on p. 241, may be drawn to show that the term-relations in both are the same. It should be noted that all the prosyllogisms in both forms are enthymemes of the third order and that the last argument, the final episyllogism, is an enthymeme of the first order in the Goclenian and of the second order in the Aristotelian sorites. Furthermore, as a rule sorites of either kind are in the first figure, though in rare cases they may be in the second and third.

CHARACTERISTICS AND RULES OF THE GOCLENIAN SORITES. In this form the first proposition is a major premise; all the rest are minors except the last which is a conclusion. The conclusion of each prosyllogism becomes the major premise of the adjacent episyllogism.

When, as in nearly all cases, the component arguments are in the first figure a Goclenian sorites should be constructed according to the following rules:

1. *Only one premise, the first, may be negative.*
2. *Only one premise, the last, may be particular.*

1. Violation of the first rule would result at once in an illicit process of the major term. Stated in a more general way the reason is that the Canon of the first figure prohibits a negative minor, and in the Goclenian Sorites all the premises except the first are minors.

2. If any premise except the last were particular, the conclusion of the syllogism in which such violation occurred would be particular; but since this conclusion is the major premise of the next argument, and since in the first figure the major premise must be universal, further inference would be impossible by rea-

son of an illicit middle. Our example of the Goclenian Sorites may be completed as follows:

(1) An animal is an organism
A quadruped is an animal
∴ A quadruped is an organism.

(2) A quadruped is an organism
A horse is a quadruped
∴ A horse is an organism.

(3) A horse is an organism
Bucephalus is a horse
∴ Bucephalus is an organism.

CHARACTERISTICS AND RULES OF THE ARISTOTELIAN SORITES. The first proposition of an Aristotelian Sorites is a minor premise; all the rest are majors except the last which is a conclusion. The conclusion of each prosyllogism becomes the minor premise of the adjacent episyllogism. As ordinarily constructed in the first figure this form is governed by the following rules:

1. *Only one premise, the last, may be negative.*
2. *Only one premise, the first, may be particular.*

1. If any premise except the last were negative, the conclusion of the argument in which such violation occurred would be negative; but this conclusion as minor premise of the succeeding syllogism, would render further inference impossible because of an illicit major.

2. Since in the first figure the major premise must be universal, and since in this form all the premises except the first are majors, it is evident that only the first may be particular.

Our example of the Aristotelian Sorites involves the following completed syllogisms:

(1) A horse is a quadruped
Bucephalus is a horse
∴ Bucephalus is a quadruped.

(2) A quadruped is an animal
Bucephalus is a quadruped
∴ Bucephalus is an animal.

(3) An animal is an organism
Bucephalus is an animal
∴ Bucephalus is an organism.

HYPOTHETICAL SORITES. Hypothetical propositions may enter into the structure of either form of the sorites. The conclusion will be hypothetical if all the arguments are pure hypothetical syllogisms; it will be categorical, however, if the last argument is a mixed hypothetical. The student may easily construct a hypothetical sorites by substituting equivalent hypothetical propositions for the categorical statements found in the preceding examples.

IV. THE EPICHEIREMA

An epicheirema is a condensed polysyllogism of the regressive type in which the episyllogism is conjoined with a proof of one or both of its premises. If the proof is offered for one premise only, the epicheirema is called Single; if for both, it is called Double. The enthymeme which appears in either or both of the premises is always of the first or second order.

We may take our illustration of a complete regressive polysyllogism and by omitting one of the premises of the prosyllogism obtain an example of a single epicheirema; thus:

All virtues are ennobling
Humility is a virtue, because it is a habit of doing good
∴ Humility is ennobling.

Using the same illustration we may by adding a reason for the major premise of the episyllogism obtain the following example of a double epicheirema:

All virtues are ennobling, for whatever exalts the soul is ennobling
Humility is a virtue, for it is a habit of doing good
∴ Humility is ennobling.

V. EXTRA-SYLLOGISTIC REASONING

In treating of "Eduction by Converse Relation" (p. 157) we found it necessary to distinguish between the ordinary copula and the copula of relation. On the basis of this distinction we were able to explain the peculiar process of immediate inference by which the mind passes from two terms related otherwise than as subject and predicate to the same terms related conversely. We have now to consider certain processes of mediate inference in which each component judgment contains a copula of relation. The most familiar example of this sort of reasoning is the *a fortiori* argument in which it is pointed out that there is a stronger reason for relating two terms in a specific way than for relating one of these terms and a third in the same way. Thus, granted that Shakespeare is greater than Wordsworth and that Wordsworth is greater than Longfellow, then for a stronger reason *(a fortiori ratione)* Shakespeare is greater than Longfellow. Such mediate inference can hardly be identified with the syllogism; for on the ordinary subject-attribute doctrine of the copula, the three judgments exhibit

four terms: Shakespeare, Wordsworth, greater than Wordsworth, greater than Longfellow. It seems advisable then to regard the reasoning as extra-syllogistic According to this interpretation there would still be three terms as in other forms of mediate inference but the terms would not be connected as subject and attribute.

In addition to the *a fortiori* argument there are other instances of mediate inference which seem impossible to classify. If they were regarded as syllogisms some of them, like the *a fortiori* argument, would be said to possess four terms and others as many as five. In the following case there are five terms:

A is the father of B
C is the son of B
∴ A is the grandfather of C.

Even when the mediate inference is made up of judgments that express time or place relations, the number of "syllogistic" terms may be five. For instance:

Washington is south of Philadelphia
Buffalo is north of Philadelphia
∴ Buffalo is north of Washington.

Or again:

A was elected two years after B
B was elected the same year as C
∴ A was elected two years after C.

In view of the rule that a syllogism must have three and only three terms it is impossible to consider the preceding arguments as cases of syllogistic reasoning to which the *Dictum de Omni et Nullo* can be applied. It follows then that in judgments composing inferences of this character the copula should be looked

upon not as "is" but as a copula of relation. By interpreting the copula in this sense we are able in every case to isolate three and only three terms and thus fulfill what seems to be a general condition of mediate inference. Moreover introspection appears to favor the opinion that our thought centers not upon the three "syllogistic" terms but upon the three object terms which are connected by such links as "is less than," "is the brother of," "is prior to," etc.

We may conclude then that the *a fortiori* argument and similar forms of mediate inference are genuine cases of extra-syllogistic reasoning. The mediate axiom underlying them all seems to be some such principle as the following: Two terms conceived to be related otherwise than as subject and attribute to a third term are related to each other in every way implied by their joint relation to the third term. Of course what relation may be implied depends upon the matter of thought, and in the long run a great deal of extra-syllogistic reasoning must rely for its validity upon the perceived connections between objects in a restricted universe of discourse—the members of a family, groups of stars, the poets of a people or of the world, places in geography, dates in history, trees in a forest, etc.

QUESTIONS AND EXERCISES

1. What is an Enthymeme? What is meant by an Enthymeme of the First, Second, and Third Order?
2. In dealing with an enthymeme of the first order how can you tell whether the argument is categorical or not?
3. Complete the following syllogisms:
   (1) The statement that England persecuted the Colonies endures; therefore the statement is not a lie.

(2) Blessed are the clean of heart, for they shall see God.

(3) War will be declared because the debt will not be paid.

(4) No cowards are trustworthy, and these men are cowards.

(5) He that is of God heareth the words of God. Therefore you hear them not.

(6) Only when a student has been industrious will he be successful; hence you will not be succsuccesful.

(7) Many will go hungry, because the cost of living will increase.

(8) Either the overture or the finale is playing now, and it's too late for the overture.

4. What is a Polysyllogism? Give an example.

5. Define a Prosyllogism. An Episyllogism.

6. Show that the *Dictum de Omni et Nullo* applies to the polysyllogism.

7. Describe the Progressive and Regressive methods of reasoning. Illustrate both.

8. What is a Sorites?

9. Define and illustrate the Aristotelian and Goclenian forms.

10. Show by means of Euler's Circles that the term-relations of both are the same.

11. State and prove the rules of the Goclenian sorites.

12. State and prove the rules of the Aristotelian sorites.

13. Reduce an example of a categorical sorites to the hypothetical form.

14. Employ the following sets of related terms (systems) to construct sorites in both the Aristotelian and Goclenian forms:

(1) Organisms, plants, flowers, roses, American Beauties.

(2) Men of influence, men of power, men with trained intellects, professional men, lawyers, John.

(3) Expression of human ideals, literature, poetry, the epic, Paradise Lost.

15. Define an Epicheirema.

16. Employ the terms given in Question 14 to construct three Double Epicheiremas.

17. Define an *a fortiori* argument.

18. Why should such arguments be regarded as extra-syllogistic?

19. What is the nature of the copula in the propositions which constitute *a fortiori* syllogisms?

20. State the mediate axiom which seems to underlie all extra-syllogistic reasoning.

21. Construct an *a fortiori* argument in which on the subject-attribute interpretation of propositions there would be five terms.

22. Show that the *Dictum de Omni et Nullo* cannot be applied to your example.

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CHAPTER XXIII

FALLACIES

ANY deviation from logical procedure may be called a fallacy. This wide application of the term includes obvious infractions of the general and special rules of the syllogism—Formal Fallacies—as well as more subtle errors—Material Fallacies which may exist even when an argument has every appearance of being sound. Strictly speaking it no more lies within the province of Logic as a science to treat of fallacies than it lies within the scope of Mathematics to point out the countless ways of miscalculation. There is, however, this difference: Mathematics and the more purely technical sciences deal largely with exact symbols whereas Logic must take account of language as the medium of thought.

After all we do not commonly think in symbols or schemes, and an excessive use of these artificial aids in bringing to light the bare bones of reasoning is not merely bewildering but quite misleading. The living word, the expression of an intelligence ever striving after freshness and vigor of meaning, ever alert to wedge new significance into familiar forms, has been traditionally and will be to the end the chief concern of logical discipline. Language is, as we have seen, an instrument for thinking and consequently enters into the very nature of the mind's activity. Thought is

one, and its matter is inseparable from its form. So true is this that many an earnest writer, deploring their separation even for the provisional purpose of explaining the laws of inference, has decried anything like a purely formal or symbolic Logic. That they have good grounds for such protest will be granted by everyone who recalls (a) the exceptions to the general and special rules of the syllogism; (b) the difference of opinion about the nature of certain activities—for example, extra-syllogistic reasoning; and above all (c) the inability of logicians to reduce to any sort of formula processes by which we sometimes arrive at practical certainty—for example, cases of reaching conviction on circumstantial evidence.

IMPORTANCE OF STUDYING FALLACIES

1. The practice of investigating sources of error in reasoning will first of all emphasize as nothing else can the unity of matter and form in thought. It will put us on guard against easy acceptance of arguments which are apparently, that is, formally, valid.

2. It will beget in us a sanely critical attitude towards the language of everyday life and help us to discern what is *not* fallacious. Perhaps the cry of "fallacy" is too often raised, for it occasionally happens that in spite of formal irregularities, in spite even of seeming incongruities in matter, inferences must be regarded as valid. Familiarity with the nature of common errors, especially of the material sort, will teach us that an assumption is sometimes permissible even when it seems surreptitious, that a proof should not always be rejected because it is loosely constructed, that the demand for precision may often be too

exacting, that in general a good deal of give and take in the exchange of arguments is not only necessary but highly desirable.

3. The study of fallacies will enable us to avoid the pitfalls of reasoning. It is with the thinker as with the painter or musician—he can improve his future work by avoiding the faults he *knows* he has committed in the past.

4. Criticism is ineffective as well as unscientific when it goes no further than the mere assertion that an argument is false. For our own satisfaction and the enlightenment of an opponent we should, if possible, indicate the precise point at which in a given case thought began to go astray. Obviously we cannot do this without acquainting ourselves with the ordinary sources of fallacious reasoning.

KINDS OF FALLACIES

1. FORMAL FALLACIES, or violations of the special and general rules of the syllogism, are manifestly limited in number and easy to detect. They have been met with and explained at various points and in different bearings during our discussion of the categorical, hypothetical and disjunctive syllogisms. In what follows, then, detailed reference to these more obvious deviations from logical procedure may be omitted.

2. MATERIAL FALLACIES, or errors which vitiate arguments that are faultless in form, can hardly be numbered and are difficult to classify. There are ten ways of being wrong to one of being right, and a step may be false from more than a single point of view. Of the various attempts that have been made to

resolve material fallacies into a semblance of order Aristotle's classification stands out as the most successful. Besides furnishing us with a tolerably complete list of mistakes in reasoning it has given us the names by which these mistakes are generally known. We may with profit, therefore, adopt this traditional division.

ARISTOTLE'S CLASSIFICATION

BASIS. Aristotle's grouping of fallacies is based on the fact that erroneous conclusions have their source sometimes in the language employed and sometimes apart from it. Hence there are two chief headings: Fallacies *in Dictione,* due to ambiguous expressions and constructions; and Fallacies *extra Dictionem,* due to other considerations. The complete division is as follows:

Material Fallacies

in Dictione	*extra Dictionem*
1. Equivocation	1. Accident
2. Amphiboly	2. *Secundum Quid*
3. Composition	3. Ignoring the Issue
4. Division	4. Begging the Question
5. Accent	5. False Cause
6. Figure of Speech	6. Consequent
	7. Many Questions

I. FALLACIES IN DICTIONE

1. EQUIVOCATION. It is a familiar fact that most terms have more than one meaning. Indeed only technical names are strictly univocal. Hence the fallacy of equivocation consists not in employing a term which is capable of two or more meanings—for that is generally unavoidable—but in actually applying it

to different things as if they were the same. All mistakes due to the language in which an argument is expressed are, broadly speaking, equivocal; for this very reason the name "equivocation" should not be given to a fallacy that may be otherwise designated. Frequent discussion of the meaning of words seems to afford no guarantee that they will be used with proper discrimination. For example, the following equivocations are common: "law" in the legal sense is talked about as if it were quite the same as the moral law; so-called "morality without religion" is identified with morality based on religion; punishment as a corrective is mistaken for punishment as a measure of retributive justice; zeal is cried down as fanaticism and fanaticism is cried up as zeal, cures by suggestion are proclaimed as "miracles," material progress as "advance in civilization," a reign of terror as a "revolution."

Instances of equivocation are always in the nature of a four-term construction (p. 196). Accordingly they are also, though much too vaguely, called fallacies of Shifting Terms or—when neither the major nor the minor is involved—fallacies of Ambiguous Middle. There is an obvious equivocal middle in the following example:

A state is a condition
Peru is a State
∴ Peru is a condition.

An error which does not conform to the definition of equivocation, but which can hardly be called anything else, consists in applying two different names to the same thing, thereby treating it as if it were more than one. Instances of this fallacy occur when dis-

carded theories, rejected policies, and discredited social and religious movements are revived. They are given new names and for a while flourish as novelties; but it rarely happens that they persist long without being recognized as the same old things. Thus, what scientists now generally agree to call "hypnotism," was at one time known as "mesmerism" and at another as "animal magnetism." "Agnosticism" from the religious point of view is the same as "scepticism," which is the same as "infidelity." "Taking one's ease at one's inn" does not differ from "loafing." "Sovietism" is pure and simple "communism." An enemy's occupation of a country may not seem to be "aggression" or retaliation if it is advertised as a "measure for reparation." Careful thinkers will always make sure that new names really signify new things.

2. AMPHIBOLY. Ambiguity due to the arrangement of words gives rise to the fallacy called Amphiboly. This error is perhaps most frequently caused by misplaced relative clauses and prepositional phrases. Thus, in the sentence, "He had a book in his hand which was spotted with ink," the relative clause may modify either "book" or "hand"; and in the command, "Instruct him to do it in the simplest possible way," the prepositional phrase may refer either to the manner of instructing or the manner of doing. The enigmatical replies of the ancient oracles were often good examples of amphiboly; they were no better, however, than the famous prophecy of Shakespeare's witch in *Henry VI*: "The duke yet lives that Henry shall depose."

3. COMPOSITION. Shifting a term from a distributive to a collective application is the source of the fallacy called Composition. In arguments that con-

tain this mistake a term is first used in a divided sense *(in sensu diviso)* and further on in a composite sense *(in sensu composito.)* The error is committed by those who contend that a team on which every man is a star will be consistently victorious over teams made up of inferior players; or—to abbreviate the well known sophism of the Utilitarians—that everyone desires the happiness of all because everyone desires his own happiness. A standard illustration of composition is the following argument.

All the angles of a triangle are less than two right angles
A, B, and C are all the angles of a triangle
∴ A, B, and C are less than two right angles.

If in the foregoing syllogism the middle term in the minor premise stands for "all the angles considered together" the inference is invalid; otherwise it is acceptable. Terms that are taken in a divided sense may not sustain the same relations as terms that are taken compositely. For example:

The men who spoke were physicians and surgeons
He is one who spoke
∴ A, B, and C are less than two right angles.

If in the major premise of the foregoing argument "physicians" and "surgeons" are thought of as divided, the conclusion, in which they *must* be thought of as combined in a single person, would be fallacious.

The puzzle which seeks to make a man contradict his answer to one question by his answer to another is a fallacy of composition. Thus, it may be asked, "Will one straw break a camel's back?" The answer of course will be, "No." "Will two?" "No." And so on. The questioner finally points out that in the

long run the addition of one straw will be enough to break the camel's back. The victim is supposed to be so embarrassed by the self-contradition into which he has been driven that he will fail to insist upon the impossibility of one straw producing the gross effect except in combination with all the others. The illustration may be varied by beginning with the following questions: "Will the loss of one hair make a man bald?", "Will one grain of sand make a pile?", "Will one blade of grass make a meadow?", "Will one chapter make a book?"

The reasoning of the loafer and the spendthrift amounts to a fallacy of composition: the loafer says, "I don't need to work this afternoon, nor tomorrow, nor next week, nor the week after; therefore I don't need to work at all"; the spendthrift says, "I can afford this luxury or that or the other; therefore I shall be able to afford them all."

4. DIVISION. When an inference involves a term which is used first collectively and afterwards distributively the fallacy committed is called Division. This error is therefore the opposite of composition. The following arguments may serve as illustrations:

(1) All the flowers in yonder vase make a pretty picture
There is a violet in yonder vase
∴ The violet makes a pretty picture.

(2) Eight is an even number
Five and three are eight
∴ Five and three are even numbers.

(3) Those who contributed gave fifty dollars
Mary contributed
∴ Mary gave fifty dollars.

In the first of the foregoing syllogisms there is an illicit division of the middle; in the second an illicit

division of the minor; and in the third an illicit division of the major. The ambiguity in each case is caused by employing a term first in a composite and then in a divided sense.

An uncharitable man probably salves his conscience by a trick of reasoning in which the fallacy of division is prominent; thus, he may argue: "I can't afford to help A and B and C and all who come to beg, so I am not obliged to help any of them." Similarly a person could be charged with the fallacy of division if he insisted that because the plays of Shakespeare represent the greatest dramatic output of all time, therefore *Henry IV* is a masterpiece.

5. ACCENT. In English the fallacy of accent, which is confined for the most part to the spoken language, may be committed by (a) stressing one rather than another syllable of a word or (b) by emphasizing one rather than another word in a sentence.

(a) Placing the accent on the first instead of the second syllable of such words as "gallant," "incensed" and "mankind" will yield a change of meaning; yet the confusion which might result in these and other cases of the kind would be negligible. No one for instance could be taken in by the following argument:

Mankind are not women
The beings that compose the human race are mankind
∴ The beings that compose the human race are not women.

(b) Ambiguities of a more serious kind are often caused by misplaced emphasis. For example, the proposition, "He may not act against his superior" can be given a different reading for every word it contains, thus:

He may not (but others may).
He *may* not (though he is in a position to do so).
He may *not* (though it is likely he will).
He may not *act* against his superior (but he may speak against him).
He may not act *against* his superior (yet he may act in behalf of his superior).
He may not act against *his* superior (but against another's).
He may not act against his *superior* (yet may act against an inferior).

Italics are sometimes used to indicate emphasis. It would be misleading, however, to introduce italics into a quotation without noting that they were absent in the original text.

Irony, which expresses the opposite of what is meant, may be lost through failure to emphasize properly; and on the contrary a statement intended to be literal may by false reading receive an ironical turn. For example, the sentence, "He is a fine fellow," may carry praise or blame, depending upon how it is spoken.

6. FIGURE OF SPEECH. If one should think that this fallacy on account of its name has anything special to do with figurative language, one could be charged with committing the fallacy itself. The word "figure" in the title signifies "form" in the sense of structure, and the fallacy comes from attributing some sort of correspondence in meaning to words and phrases that are similarly constructed. The simplest cases involve compounds with the same prefixes or suffixes. For example, a person might reason that because "impatience" and "impotence" begin with the same negative particle they both stand for negative concepts. A good illustration of the fallacy is the argument in which John Stuart Mill contended that

as what people actually see is "visible" and what they actually hear is "audible," so what they actually desire is "desirable." As a matter of fact "desirable" means not only what can be desired but what ought to be desired.

In the two following syllogisms the figure of speech lurks in a sameness of phrase structure.

He who is most hungry eats most
He who eats least is most hungry
∴ He who eats least eats most.

The difference here presented may be solved by pointing out that the phrase "eats most" in the major premise means "*will* eat most" and that the phrase "eats least" in the minor premise means "*has actually* eaten least." When these true meanings are brought together in the conclusion the original absurdity seems to disappear in the proposition, "He who has eaten least will eat most."

No cat has two tails
This cat has one tail more than no cat
∴ This cat has three tails.

Here of course it is the phrase "no cat" which causes all the trouble. In the major premise the word "no" has two functions: it distributes the term "cat" and makes the copula negative; in the minor premise "no" simply negates the copula in the equivalent phrase "a creature that is not a cat." The minor premise should therefore read "This cat has one tail more than a creature that is not a cat."

II. FALLACIES EXTRA DICTIONEM

Fallacies *extra dictionem* are alike in one respect; *they all originate in an assumption which is not war-*

ranted by the language employed. Adequate criticism of these errors, therefore, consists in pointing out what has been assumed.

The fallacies of Accident and *Secundum Quid* are sometimes treated as if there were no radical difference between them. Writers who take this point of view use "Accident" as a generic term to cover all errors that could possibly be called by either name. This genus they divide into "Simple," "Converse" and "Specific" identifying "Simple Accident" with the fallacy *A dicto simpliciter ad dictum secundum quid,* "Converse Accident" with the fallacy *A dicto secundum quid ad dictum simpliciter,* and "Specific Accident" with the fallacy *A dicto secundum quid ad dictum secundum quid.* Instead of following this departure from traditional usage we shall consider Accident and *Secundum Quid* as two distinct kinds of false reasoning. We shall, however, lay stress on the fact that they always appear together, that in other words an argument which from one point of view reveals the fallacy of Accident will likewise, though from another point of view, reveal *Secundum Quid,* and vice versa. The reason for maintaining a distinction between these errors is based on the different assumptions they make; what Accident assumes bears directly on the use of terms, whereas what is taken for granted in *Secundum Quid* concerns the relation of two propositions. In the succeeding paragraphs this point will be touched upon again.

1. ACCIDENT. The term "accident" as here employed means any predicate which is not commensurate with its subject. This use of the word is strictly technical and should not be extended to either the category or the predicable accident. Commensurate

terms occur only in definitions and identical propositions; in other affirmative propositions the intension of the subject is greater or less than that of the predicate which is consequently always an accident. Thus, when the subject is a genus the predicate is an accident in the predicable "species" or "property," for example, "Some animals are birds" (species), 'Some animals are feathered (property) : and when the subject is a species the predicate is an accident in the predicable "genus," "differentia" or "accident" proper; for example, All men are animals" (genus), "All men are rational" (differentia), "All men are warm-blooded" (accident). These several relations obtain because—with reference to a given judgment—it is by accident (*per accidens*) that a genus or differentia should be concreted in one species or individual rather than in another—that an "animal," for instance, should be a "man" rather than a "brute," or that a "rational being" should be a "man" rather than a "pure spirit." Hence the species of the individual is an accident with reference to a genus, and genus, differentia, and accident proper are accidents with reference to their species.

It is only in A propositions that the full significance of these relations is brought out. As we have seen, a typical A proposition is converted *per accidens,* that is, in accordance with the undistributed character of its accidental predicate. Simple conversion of A propositions is not valid unless the predicate as well as the subject is a species. When this is the case, however, the two terms are identical in extension and meaning, so that what is true of one is true of the other. Now in effect the fallacy of Accident is based on the assumption that an accident is commensurate

with its subject, and that consequently an ordinary A proposition is *simply* convertible. As a *false principle* of reasoning the assumption may be given the following expression: *What is predicable of a subject is predicable of its accidents.* Let us take an illustration:

Fidelity is a virtue
Allegiance to an ignoble cause is fidelity
∴ Allegiance to an ignoble cause is a virtue.

In this syllogism "a virtue" is predicated first of the subject "fidelity" and then of "allegiance to an ignoble cause," an accident of "fidelity." "Allegiance to an ignoble cause" is here an accident because it is a kind of "fidelity," that is, "fidelity" not in its generic or essential meaning, but in a modified sense hardly indeed worthy of the general name. If the minor premise of the argument were simply convertible, as the assumption of Accident implies, there would of course be good ground for the conclusion.

Let us take another illustration:

Spirituous liquors act as poison
Wine is a spirituous liquor
∴ Wine acts as poison.

In this as in the preceding argument the fallacy is reducible to an illicit conversion of the minor premise, but since the two syllogisms present a different arrangement of "subject" and "accident" the false mediate principle expressed with direct reference to the first form should be modified for the second form as follows: *What is predicable of an accident of a term is predicable of another accident of the same term.*. In our example the "term" to which the so-called principle directs attention is "spirituous liquor"

—but only as it is used generically in the minor premise. As subject of the major premise "spirituous liquors" does not carry merely the meaning of the genus; it has an added meaning and is, like "wine," a species (and therefore an accident) of "spirituous liquor" in the generic sense: this is so because it cannot take its given predicate without being qualified in thought by some such limiting clause as "when used to excess." The two meanings of "spirituous liquor" stand in the same relation as the two meanings of "fidelity" in the preceding example, except that "fidelity" is used generically in the major and specifically in the minor. The fallacy under consideration consists in affirming that because the major term, "acts as poison," is predicable of one accident, "spirituous liquors," it is predicable of the other, "wine."

SIMPLE, CONVERSE, AND SPECIFIC ACCIDENT. Fallacies of accident are said to be of three kinds depending on the order in which the assumptions regarding a given term are presented. If, for instance, the assumptions are arranged so as to render the first use of a term abstract or general and its second use concrete or specific, the error is called Simple Accident; if the arrangement is reversed so as to render the first use concrete or specific and the second abstract or genral, the case is one of Converse Accident; finally, if both the first and the second use is rendered concrete or specific, the mistake may be classified as Specific Accident. Any of the three terms of an argument may have incommensurate values imparted to it, though as a rule the matter *extra dictionem*—the assumption, amounting to the qualification that needs to be supplied—centers about the middle term. The first of the foregoing syllogisms is an instance of

Simple Accident, the second an instance of Converse Accident. Specific Accident may be illustrated as follows:

Education develops the subject's intellect
The training that animals receive is education
∴ The training that animals receive develops the subject's intellect.

In this argument the assumption again draws attention to the middle term. Not every *kind* of education develops the intellect, and to train animals is to educate them only *in a way of speaking.*

The fallacy of Accident does not always take the first figure. Indeed the more frequent as well as the more flagrant cases appear in the third figure. For example,

Giving money to the poor encourages idleness
Giving money to the poor is charity
∴ Charity encourages idleness.

Here again is an instance of Specific Accident. The middle term is used twice in an accidental sense, for idleness is encouraged chiefly by giving money to the *shiftless* poor, and it is only giving money to the *deserving* poor that merits the name of charity.

It would appear that the fallacy of Accident is not confined to mediate reasoning. A great many popular opinions are merely "snap judgments" which seem to be the result of false immediate inference. Most of these mistaken notions arise from a total disregard of what is implied by the subaltern relation of opposition. The assumption, for instance, that if the subalternate is true the subalternant is also true appears to be a fruitful source of Converse Accident. Thus, a well known scientist has made a hasty generalization

about the inefficiency of college students on the ground that a few graduates who entered his laboratory were unfitted for the work he set them to do; many a climate has been branded as "impossible" by visitors to a certain locality who happened to experience a week or two of disagreeable weather; "American traits" of divers and diverse kinds have been summarized in books by foreign notables after lecture tours that were as brief in time as they were limited in space.

2. SECUNDUM QUID. This title—a phrase out of the Latin description, *Fallacia a dicto simpliciter ad dictum secundum quid*,—means "in a qualified sense." The fallacy assumes the right to reason from one predication to another even when the one is true absolutely while the other is true only conditionally. For example:

Leather is a valuable commodity
Old shoes are leather
∴ Old shoes are a valuable commodity.

At least two mistakes stand out in this argument: if attention is centered on the middle term a fallacy of Simple Accident can be discerned; and if regard is given rather to a comparison of the statements as such a fallacy of *Secundum Quid* is apparent. From the latter point of view, the major premise is in the nature of a general assertion that would ordinarily be granted just as it stands. The minor premise, on the contrary, seems to be incomplete; it lacks a qualification which could perhaps be best supplied by employing some such adjective as "worn" or "torn" or "shrivelled" to modify "leather."

From this and other examples of the fallacy it may

be seen that a *dictum secundum quid* leaves an important element of the thought unexpressed. To supply the omission is usually an effective method of criticizing an argument. Sometimes a given proposition amounts to a faulty definition and at other times it is plainly unacceptable because it fails to note a telling circumstance of time, place, degree, etc. The following statements, for instance, are for most purposes half-truths which need the words in parentheses to make them useful for anything like close reasoning: Tumblers are glass (in a certain form); A book is paper (bound in sheets); Murder is taking human life (unlawfully); Gluttony is eating (to excess); Martial law is government (in a time of disturbance).

SECUNDUM QUID AND THE MORAL UNIVERSAL. In the form of *Secundum Quid* under discussion the major premise has the appearance of a general law which by means of the minor premise is applied to a particular case. As a matter of fact it is frequently a moral universal, that is, an indesignate proposition which enunciates a rule that holds good within *normal* experience. A rule of this sort has perhaps many exceptions, which, however, for ordinary purposes of thought may reasonably be overlooked. The predicates of moral universals are usually terms that set forth some prominent feature of a class: for instance, characteristics of animals—Dogs bark, Cats have long tails; mental or physical traits of races—The Japanese are undersized, The Scotch are thrifty; qualities that are usually associated with familiar objects—Stone is hard, Doors have hinges. To all these examples there are exceptions, and consequently the judgments are not really universal. Since, then, the subject of a moral universal is not distributed and

since in many cases its undistributed character would reveal an illicit middle, the argument in which it occurs may be formally invalid. Thus the error in the following syllogism is rather an illicit middle than either simple accident or *secundum quid*.

Americans will defend their country
The Pacifists of Illinois are Americans
∴ The Pacifists of Illinois will defend their country.

A more interesting instance is the classical fallacy:

Every rule has exceptions
This major premise is a rule
∴ This major premise has exceptions.

But the exception to a rule contradicts the rule, hence the major premise and its contradictory may be true at the same time.

Perhaps the simplest solution of the difficulty is to point out that the major premise in spite of its form can be no more than a moral universal; for one cannot without self-contradiction admit an exception to the rule that "every rule has an exception." What is intended to hold good without exception, therefore, is the proposition that "most rules have exceptions." A similar explanation will reveal the absurdity of universal scepticism: to doubt everything is a contradiction in terms, for at least one cannot doubt that one doubts. Moreover, one cannot doubt except *secundum quid*, that is, by doubting something specific: to doubt simply, or in other words to suspend judgment about no definite object is an impossible feat. Hence the proposition "All things are doubtful" is at best a moral universal, and the same may be said of that other self-contradictory assertion, "All men are liars."

KINDS OF SECUNDUM QUID. We have pointed out

that the matter *extra dictionem* (the assumption) in *secundum quid* bears upon the way in which subject and predicate are connected in two propositions. In the form we have just considered the first of the statements compared is simple while the second needs qualification. But besides this form there are two others: the fallacy *A dicto secundum quid ad dictum simpliciter,* in which the first statement is acceptable only if qualified while the second is simply granted; and the fallacy *A dicto secundum quid ad dictum secundum quid,* in which both statements require modification before they are admitted. The following syllogisms will be found to contain these two errors:

"Patriotism is the last refuge of a scoundrel"
Loyalty to one's country is patriotism
∴ Loyalty to one's country is the last refuge of a scoundrel.

Surely Dr. Johnson never intended to connect the predicate of his famous aphorism with "patriotism" in an unqualified sense.

Whoever takes the property of another is guilty of a serious crime
He has taken the property of another
∴ He is guilty of a serious crime.

Neither of the premises in this argument is admissible without qualification; the major premise is not true unless the act is deliberate and the property has considerable value; the implication in the minor premise would be misleading if, for instance, the property had been taken by mistake. Both premises are therefore *dicta secundum quid.*

In connection with the fallacies of Accident and *Secundum Quid,* which as we have seen generally occur together, it should be observed that the indifferent

use of abstract and substantial terms is a frequent source of error. Hence care should be exercised not only in criticizing but also in formulating arguments which deal with names of materials, *wood, iron, stone, cloth,* etc., and with such "mixed concepts" as *beauty, government, institution, religion, agency, justice, zeal,* and *reformation.*

COMPARISON OF ACCIDENT AND SECUNDUM QUID. The following summaries may help to show the correspondence between the fallacies of Accident and *Secundum Quid.*

A. Fallacies of Accident

(Assumption centered upon a term

1.	Simple Accident	First use of term—generic, abstract. Second use of term—specific, concrete.
2.	Converse Accident	First use of term—specific, concrete. Second use of term—generic, abstract.
3.	Specific Accident	First use of term—specific, concrete. Second use of term—specific, concrete.

B. Fallacies of *Secundum Quid*

(Assumption centered upon a judgment as such)

1. *A dicto simpliciter ad dictum secundum quid*
   First statement true simply.
   Second statement needs qualification.
2. *A dicto secundum quid ad dictum simpliciter*
   First statement needs qualification.
   Second statement true simply.
3. *A dicto secundum quid ad dictum secundum quid*
   First statement needs qualification.
   Second statement needs qualification.

3. IGNORING THE ISSUE. The traditional Latin name for this fallacy is *Ignoratio Elenchi,* which means "ignoring the refutation." An opponent can be refuted only by establishing the contradictory of his conclusion; by doing anything else one seems to display a certain ignorance of what is required. The

fallacy includes every form of "arguing beside the point," "evading the issue," "mistaking the question," or drawing "irrelevant conclusions." If, for instance, evidence has been offered to show that a man committed perjury it would profit little to prove before a competent jury that he possessed an enviable reputation for honesty. The fallacy is commonly committed by those who object to a new enterprise on the ground that there are evils connected with it. The real question of course is whether the change will be for the better. Evils probably exist under present conditions, or the proposal would not be made; the objectors should demonstrate that there is more good and less evil under the existing system than there would be under the new plan. Quibbling is a clear case of Ignoring the Issue inasmuch as it attributes to some trifling detail all the importance of the main question. Other instances of the fallacy have been given special names to indicate the directions in which they depart from arguments *ad rem.*

The *argumentum ad hominem* is an attempt to gain a point by launching an attack upon the ability or character of an adversary. What a man practices as distinguished from what he preaches is a personal matter which can never be alluded to without committing this fallacy. There are worse things, however, than a bit of questionable Logic; and when an opponent's reasoning is evidently insincere, when he is plainly quibbling, or talking for talk's sake, attention may be called to the fact by referring to the discrepancy between the things he says and the things he does; his conduct doubtless is sincere, but if so it must be based on motives that contradict his public utterances. It would be also an argument *ad hominem* to

contend that because an opponent's presentation of his case is weak the case itself is not strong.

The *argumentum ad populum* implies a more or less frank refusal to discuss a question on its merits. The purpose of one who commits this fallacy is to persuade rather by entreaty than by force of reasoning, and the method employed involves an appeal to the passions and prejudices of those who are addressed. Nothing perhaps contributes more to misunderstandings among men than exhortations intended to arouse race hatred, religious feeling or political animosity. A special form of this fallacy is the *argumentum ad misericordiam,* a favorite expedient of criminal lawyers to move the jurors to pity for the prisoner at the bar.

The *argumentum ad baculum* is the appeal to the "big stick." In this case the issue is evaded by an attempt to impress people with a fear of the consequences if an opinion advanced, a movement advocated, or a condition imposed be not accepted. Only those whose cause is weak have recourse to such a method of persuasion. Threat is the most illogical of human appeals and it is a sad commentary on the courage of men that it "works" so commonly and so effectively.

The *argumentum ad ignorantiam* seems to assume that there is virtue in ignorance. Curiously enough the assumption is employed for proof as well as disproof: on the one hand an opinion or a theory is declared to be established because it cannot be successfully refuted; and on the other hand ignorance of *how* a thing can be is offered as convincing evidence that it cannot be at all. Of course when ignorance is the very thing in question an inference based upon it

may constitute an argument *ad rem.* For example, a well-attested fact which if it were natural could be explained by natural laws but which, far from yielding to such explanation, exhibits characteristics that make it a case apart, must be regarded as at least preternatural.

The *argumentum ad verecundiam* is calculated to overwhelm an opponent with shame at his temerity in opposing a great authority. Invoking the aid of authority to strengthen an argument is not in itself illegitimate; on the contrary, to cite the opinion of learned men in support of adequate reasons is heaping up the proof. A fallacy may be charged only when reasoning is called for and nothing but authority given. The error would be particularly flagrant if the authority named had no claim to respect as an expert on the subject under discussion. Reporters who interview successful inventors, popular actresses and famous generals for the purpose of getting the last word on theology, sociology or politics are guilty of this fallacy.

4. BEGGING THE QUESTION. The traditional Latin title of this fallacy is *Petitio Principii,* which means literally A Begging of the Principle but which generally goes under the name of Begging the Question. Both English renderings may be conveniently used to designate the two most familiar forms of the fallacy: (A) assuming the very proposition to be proved, and (B) positing without proof a principle wide enough to embrace the conclusion.

(A) *To offer the conclusion as a reason for itself is specifically a Begging of the Question.* The "question" as here understood is the point at issue, and since a topic under discussion always has two sides,

the result of opposing arguments will be contradictory conclusions each of which *is* the question expressed from different points of view. The fallacy is usually hidden under synonyms or phrases which imply each other: thus, a painting might be declared a copy because it does not show the marks of the original; a murderer to be insane because he lacks sufficient mentality to be guilty of crime; an act to be impulsive because it was performed on the spur of the moment; a man to have the appearance of a king because he has a regal bearing.

Every syllogism is called a Begging of the Question by those who regard the conclusion as definitely incorporated in the major premise. We have had occasion to oppose this view in discussing the nature of syllogistic reasoning (p. 188). But we have also pointed out (p. 186) that there is a real Begging of the Question in every argument whose major premise is an enumerative universal. Begging the Question rather than Begging the Principle seems the proper name for these cases because the conclusion as such must be known to the enumerator before he can announce his collective major premise.

One who begs the question is said to argue in a circle, and his argument is sometimes called a "vicious circle."

The Question-Begging Epithet. A topic under discussion may be shifted from one universe of discourse to another by means of a single misapplied epithet. When this occurs the epithet is said to be question-begging. The fallacy amounts to false classification inasmuch as the term about which there is question can neither be included in nor identified with the epithet. This illogical procedure aims to put an ar-

gument on an entirely new basis; for of course a topic which is reclassified by a question-begging epithet may have a great many fresh things said about it. For instance, to speak of war as "blood-letting" enables the jingoist to turn his fancy loose in the field of therapeutics, whereas to speak of war, even of defensive war, as "uncivilized" enables the pacifist to shunt into the background the all-important matter of the duty of self-preservation. The ruthless killing of helpless savages has more than once been described as "overcoming obstacles" in the laudable enterprise of "empire building." Charity as well as good Logic should warn us against the possible question-begging use of such epithets as "bolshevik," "slacker," "heretic," "anarchist"; and we should remember that the promoters of an ignoble cause are prone to elevate it to a plane of decency by calling it "religious," "patriotic," "progressive," "humanitarian."

(B) *Begging the Principle is the term applied to fallacies in which the major premise, although not an enumerative proposition, requires under the circumstances to be proved.* A good example of the fallacy is the following argument attributed to Aristotle by Galileo: "The nature of heavy things is to tend towards the center *of the universe,* and of light things to fly from it; experience proves that heavy things tend toward the center *of the earth,* and that light things fly from it; therefore the center of the earth is the center of the universe."

Perhaps the charge of begging the question or the principle is too often made on insufficient grounds. There is such a thing as an unreasonable demand for proof. For instance, with regard to our first example, if no documentary evidence could be adduced to prove

or disprove that the picture is a copy, a conclusion either way would rest solely on internal evidence, namely, on whether the painting does or does not exhibit the characteristics of the master. Likewise, for practical purposes and "for the sake of argument" a great many general statements may profitably be granted in order to establish a common basis of discussion. It will not do to take seriously the attitude which Charles Lamb adopted humorously when he refused to grant that two and two are four until he knew what use was to be made of the admission. Besides self-evident truths there are in all the natural sciences inductive laws which it would be idle to call in question.

5. FALSE CAUSE. This title has two distinct uses: it designates (A) the deductive fallacy in which from acceptable premises ridiculous, absurd, far-fetched conclusions are drawn, and (B) the inductive fallacy commonly called *Post hoc, ergo propter hoc.*

(A) As originally applied, the word "cause" in the title signified the *reason* upon which a conclusion is grounded, and the fallacy was charged against one who inferred an absurdity from an opponent's premises. The premises in themselves might be incontrovertible: they were constituted a false cause by being employed as a reason for a judgment that was not at all involved in them. For example, a person might say, "To comfort those in distress is an obligation of charity, and to be kind to the poor is to comfort those in distress"; then another might make the far-fetched deduction, "Yes, you would have our daughters associate with the scum of the earth." This retort, inasmuch as no reason for it can be found in the first statement, is clearly based on a false cause. The fal-

lacy may therefore be regarded as an unsuccessful attempt to bring about a *reductio ad absurdum.*

To force into an opponent's statement a meaning, an intention, or an animus which was obviously not in his mind and forthwith to offer the statement as a reason for one's own absurd inference is a practice that did not cease with the Sophists of ancient Athens. It is the way of the youth who on being admonished about the company he keeps exclaims, "Oh, you don't want me ever to have any fun." It is the way of the politician who when his rival contends that the Filipinos, having been promised their freedom and having shown themselves capable of self-government, should now be released from allegiance to the United States, charges the speaker with a treasonable attempt to hand over the islands to Japan.

False cause and non sequitur. False Cause in this first application of the title includes many cases of *Non Sequitur,* especially those in which the inference seems to have little or nothing to do with the premises. Since, however, the name *Non Sequitur* is both negative and generic, it should not be used to designate a fallacy to which a positive and specific title may be given.

(B) The name "False Cause" is commonly used as a variant of *"Post hoc ergo propter hoc"* to indicate the inductive fallacy of supposing that the antecedent of an event is *always,* instead of merely *sometimes,* its cause.

Popular superstitions, such as predicting ill luck if thirteen are seated at a table, or good luck if a horseshoe is hung over the door, have their origin in this fallacy. Out of it grows the habit of foretelling the future by dreams and signs. Upon it was constructed

the "science" of astrology which foreshadowed a man's destiny from his "stars." But even in the accredited sciences it is a frequent source of error. Many a field of fruitless inquiry is opened up on the hypothesis that two phenomena, one following closely upon the other, are causally related. In fact the very purpose of employing scientific methods as a means of verification implies the great danger an investigator runs of selecting the wrong antecedent as the cause of a phenomenon. Thus, before the theory of natural selection was advanced it was supposed that a rugged race of men are usually found in a severe climate because the hardships they have to undergo build up in them a power of resistance; the Darwinist, on the other hand, would contend that the inherent strength of these men is the reason why they were able to survive in such an environment. And perhaps the truth lies somewhere between these extreme views.

6. CONSEQUENT. No advantage can be derived from calling this fallacy a *Non Sequitur*. It is that, of course; but so is False Cause in its primary sense, and so are many of the fallacies *in dictione*. The *non sequitur* of False Cause is due to a perverse treatment of premises that are capable of yielding valid conclusions, whereas the *non sequitur* of Consequent lies in an assumption which bears on the premises and renders them illicit to begin with. This assumption may be specified as a failure to recognize the true relation between an antecedent and its consequent. The fallacy consists, therefore, in regarding the consequent as convertible with the antecedent. Both the name of the fallacy and this account of it suggest hypothetical inference, but the error is common to categorical reasoning also.

In the case of a mixed hypothetical argument the fallacy is committed when the consequent is affirmed or the antecedent denied. Thus, given as major premise, "If men are industrious they can make a living," and as a minor premise either, "These men are not industrious" or "These men can make a living," no conclusion is possible because the data are vitiated by an illicit assumption formally located in the minor —the assumption, namely, that the minor in either case could furnish a ground of inference.

The fallacy of Consequent is attributable to categorical arguments for similar reasons. In a manner of speaking the predicate of a categorical proposition is related to its subject as consequent to antecedent, for when a categorical proposition is expressed in hypothetical form the subject stands out as a condition upon which the predicate depends. For example, "Industrious men are able to make a living" is only another way of saying, "If men are industrious they can make a living." It is easy to see therefore why a fallacy of Consequent occurs when in the standard type of syllogism the minor premise either denies the subject (antecedent) or affirms the predicate (consequent), thus:

Industrious men are able to make a living
These men are not industrious
∴ These men are not able to make a living.

or

Industrious men are able to make a living
These men are able to make a living
∴ These men are industrious.

It is also easy to see why, with reference to immediate inference, the assumption that the subject and predicate of a categorical statement are simply convertible

constitutes a fallacy of Consequent. This erorr would be clearly exhibited in passing from "Industrious men are able to make a living" to "All who are able to make a living are industrious," or "Those who are not industrious are unable to make a living."

The fallacy of the Consequent as affecting disjunctive reasoning may be illustrated by the following syllogism:

> Either all the ship's crew were lost or some have returned
> But some have not returned
> ∴ All were lost.

Here the data are rendered worthless for inference because one of the alternatives is improperly sublated. "Some have not returned" is the sub-contrary, not the contradictory of "Some have returned." The minor premise should read, "None of the crew has returned."

7. MANY QUESTIONS. This fallacy occurs when *many* questions—two or more—are conveyed by means of a *single* question so constructed that it cannot be given an unqualified answer without sacrificing an important truth. The error is also known as Complex or Complicated Question. The "many questions" (A) may be all formally expressed in a single interrogation, or (B) only one of them may be expressed, the other (or others) being implied. In either case the interrogator intentionally or unintentionally misinterprets what amounts to a disjunctive judgment. Examples of (A) will exhibit alternatives in either the subject or the predicate: thus: "Have you and John forfeited your rights?" or "Is he a reformer and a hypocrite?" Instances of (B) conceal one of the alternatives: thus, "Where did you leave my book?", when the fact is I didn't take your

book. Such questions as these cannot be answered by "yes" or "no," or in any simple way. Instead of committing himself to a partial untruth a respondent should in the case of (A) *distinguish* between the parts of the question, and in the case of (B) *deny* the supposition involved.

Cross-examiners employ "Many Questions" in order to embarrass a witness who may think he is obliged to give a categorical answer to every query that is put. Police officials make a most pernicious use of the fallacy, when having assumed the guilt of a prisoner who may be innocent, they demand where he left the body of his victim, or where he concealed the stolen goods. "Explanations" of unconfirmed hypotheses, such as how the dead communicate with the living, are probably instances of the same error. The "riders" that are tacked on to bills which go to a governor for signature are sometimes in the nature of "Many Questions," for while the chief contents of the bill may demand immediate approval the "riding" clause may seem inexpedient to the signatory. Perhaps also any kind of *insinuation* or *innuendo*, whether it has the form of a question or not, should be included under this fallacy.

QUESTIONS AND EXERCISES.

1. What reason can you offer for going into the subject of Material Fallacies?
2. What particular advantages should come from a study of fallacies?
3. Define a material fallacy.
4. What are the two main headings in Aristotle's classification of material fallacies?
5. Does the Fallacy of Equivocation consist in employing a term which has more than one meaning? If not, how would you define it?

6. Are there cases which seem to require an extension of the application of the Fallacy of Equivocation? What is characteristic of these cases? Give examples.

7. Show that the terms *"Quaternio Terminorum,"* "Shifting Terms," "Ambiguous Middle," and "Equivocation" amount to pretty much the same thing.

8. Define and illustrate Amphiboly.

9. How is the Fallacy of Composition committed?

10. What constitutes the Fallacy of Division?

11. Examine the following arguments:

(1) Brown is both clever and good, for he is a director and all the directors are both clever and good.

(2) The wasting of a single moment can do no harm; but hours and days are so many single moments; hence the wasting of hours and days can do no harm.

(3) The company of actors made a good impression; Stetson was one of the actors; consequently he made a good impression.

(4) One slight electric impulse does not move this muscle; therefore ten in succession will not move it.

(5) I am not obliged to say prayers at any particular time so I'm not obliged to pray at all.

(6) The society works for the good of all; accordingly Smith as a member of the society works for the good of Jones who is also a member.

(7) No one who does not speak French and English is admitted; but I speak English; hence I should be admitted.

(8) A dime will go into the slot
Two nickels are a dime
∴ Two nickels will go into the slot.

12. Define and illustrate the Fallacy of Accent.

13. Accentuate the following sentence in order to bring out six different implications They may not speak ill of their friends.

14. Define and illustrate the Fallacy of Figure of Speech.

15. Explain the fallacy of the following argument:
He who gets sick needs medicine

He who is well is he who gets sick
∴ He who is well needs medicine.

16. What is the common characteristic of all fallacies *extra dictionem?*

17. Does the term "accident" as the name of a fallacy signify the same thing as the category or the predicable "accident"?

18. What is the precise meaning of "accident" as employed in connection with fallacies?

19. Point out in the following propositions which predicates are accidents according to your definition:

(1) Some flowers are orchids.
(2) Columbus was the discoverer of America.
(3) Each angle of a triangle is less than two right angles.
(4) Color is a sensation.
(5) Swans are white.

20. What is the difference between the fallacies of Accident and *Secundum Quid?*

21. On what assumption is the fallacy of Accident based?

22. Name and distinguish the three kinds of Fallacy of Accident.

23. Show that the false principle, "What is predicable of a term is predicable of its accidents," is applicable to an example of Simple Accident.

24. Show that the false principle, "What is predicable of an accident of a term is predicable of another accident of the same term," is applicable to an example of Converse Accident.

25. What does the fallacy of *Secundum Quid* assume?

26. Distinguish the kinds of *Secundum Quid.*

27. Explain the statement that "a *dictum secundum quid* leaves an important element of thought unexpressed."

28. Give three examples of half-truths which would need to be qualified before being used in an argument.

29. Discuss the fallacies in the following arguments:

(1) Religion is uplifting; but the worship of idols is religion; therefore the worship of idols is uplifting.
(2) All the actors are known to the audience; now the men and women who are masked are all the actors; consequently these men and women are known to the audience.

(3) Soldiers have their full reward in money, for they are hired men, and hired men have their full reward in money.

(4) "All men are liars," said John. But John is a man; hence his statement is false. Then its contradictory is true, and some men (perhaps all) are not liars. In such case we are not compelled to think of John as a liar. Yet if he is not a liar his assertion that all men are liars must be accepted, and we are back at the beginning again.

(5) Drinking is essential to human life; but imbibing alcohol is drinking; hence imbibing alcohol is essential to human life.

(6) He who does not think of evil is not a sinner; but he who sleeps does not think of evil; therefore he who sleeps is not a sinner.

(7) Silver is good for making spoons; but this dime is silver; therefore this dime is good for mak- spoons.

(8) Pain is evil: yet the man who seeks an operation seeks pain; accordingly the man who seeks an operation seeks evil.

30. Explain the literal meaning of the phrase *"Ignoratio Elenchi."* Give four other general names for the fallacy which bears this title.

31. Define and illustrate Argumentum ad hominem, Argumentum ad populum, Argumentum ad baculum, Argumentum ad ignorantiam, Argumentum ad verecundiam.

32. Can you discover any of these fallacies in the following arguments?

(1) It has never been known that a man rose from the dead; moreover, a case of the kind is contrary to scientific law; therefore the resurrection of Christ is a myth.

(2) You have repeatedly asserted that you love the poor and afflicted; and yet you never give a cent in charity, you never visit the sick, you don't even pay a living wage to your employes.

(3) Brutus says Caesar was ambitious. But, O Romans, consider what great gifts Caesar was preparing to bestow upon you!

(4) Gentlemen of the Jury, this prisoner should not receive the extreme penalty of the law; for if you condemn him to death you will bring sorrow into the life of his aged mother.

(5) What reason can you possibly have for doing as your propose? If you carry out your plans you will create unrest amongst the rank and file and you will call down the wrath of those in power; besides, you will be certainly exiled.

(6) Not much can be said in favor of the theory of evolution, seeing that the Tennessee legislature prohibited the teaching of it.

33. Recognizing "Begging the Question" as a generic title, distinguish between "Begging the Principle" and the specific use of "Begging the Question."

34. Examine the following arguments for either of these fallacies:

(1) All the men shook hands with me
James was one of the men
∴ James shook hands with me.

(2) The Volstead Act is beneficial; for it prevents crime, and any law that prevents crime is beneficial.

(3) A law that prohibits the use of alcohol for any but sacramental purposes is wise; the Indiana "Dry Law" does this; hence the Indiana "Dry Law" is wise.

(4) To insist on regular attendance at class is slave-driving.

(5) Benedict Arnold died a martyr to a cause.

35. Would it be a Begging of the Question first to prove the teaching authority of the Catholic Church by means of the New Testament *regarded as a historical document*, and then to use the text of the New Testament *regarded as a deposit of revelation* in order to support and explain what the Church teaches?

36. Define the deductive fallacy called "False Cause" and

the inductive fallacy more commonly known as *"Post Hoc, Ergo Propter Hoc."*

37. Can you detect either of these fallacies in the following arguments?

(1) If Catholics are obliged to accept what the Church teaches with regard to faith and morals they have no freedom of thought.

(2) You say that obedience to the will of God is the only source of happiness and that all men are obliged to conform to the will of God. Then you think men are angels.

(3) Malaria would seem to be caused by bad air, for it is rare among people who inhabit high altitudes and common among people who live in low, swampy places where the atmosphere is heavy.

(4) Statistics show that the majority of accidents occur on Friday; hence one should hesitate to undertake a journey on that day.

38. In what does the Fallacy of Consequent precisely consist?

39. Give a reason why it may be said to occur in categorical as well as hypothetical arguments.

40. Point out the source of error in the following cases:

(1) If he had worked hard he would have got a degree; but he didn't work hard; consequently he didn't get a degree.

(2) All who covet riches are worldly-minded; accordingly those who do not covet riches are not worldly-minded.

(3) Either the voluntary muscles are all striped or some of them are unstriped; but some of them are not unstriped; therefore they are all striped.

41. When does the Fallacy of Many Questions occur?

42. Point out the assumptions (possible and actual) in the following instances of Many Questions:

(1) Are Sirius and Jupiter the brightest stars?

(2) Is his mind as clear as ever?

(3) Has your neighbor paid his debts?

(4) Are you still studying Logic?

ADDITIONAL EXERCISES ON THE FALLACIES

In examining the following arguments note that some of them may contain more than one error. After solving each problem construct an original fallacy of the same kind.

1. What you buy today you eat tomorrow
   You buy raw meat today
   ∴ You will eat raw meat tomorrow. (Ancient puzzle.)
2. This proposition is either categorical or hypothetical; but it is not hypothetical; hence it is categorical.
3. Miracles cannot happen, for they are at variance with scientific laws.
4. Will a drop of water make a pool? No. Will two? No. Will three? No. But we shall get to a point where so much water has accumulated that one drop more will make a pool, so you will have to contradict yourself.
5. Whatever did not happen is not; God did not happen; therefore God is not.
6. He who loses his hat is without one; but he who possesses a hat is he who loses a hat; consequently he who possesses a hat is without one.
7. Students are either happy or industrious; these students are industrious; therefore they are not happy.
8. "He who calls you a man speaks the truth; but he who calls you a fool calls you a man so he who calls you a fool speaks the truth."
9. What's the good of prayer? I am destined to be either saved or not saved: if the first, I don't need prayer, and if the second, prayer won't benefit me.
10. If a body moves it must move either in the place where it is or in the place where it is not; but it can neither move in the place where it is nor in the place where it is not; therefore it cannot move. Zeno.
11. "You are not what I am. I am a man. Hence you are not a man."

12. The holder of one ticket will win the prize; now I am the holder of one ticket; hence I shall win the prize.
13. This man was picked up near the spot where the crime was committeed. He told a story which was probably a lie. No doubt he is guilty, for he has the appearance of a criminal.
14. Every incident of the story is true to life; at last then we have a novel which is as a whole a reproduction of actual experience.
15. No leaves except the aspen quiver in a light breeze; those leaves don't quiver in this light breeze, hence they are not aspen.
16. "I doubt everything," said the Sophomore. Could he have done so?
17. "Repentance is a good quality; wicked men abound in repentence and therefore abound in what is good."
18. Persons who do as they like deserve no special reward; the saints did as they liked; consequently they deserved no special reward.
19. All lawyers are men; few physicians are lawyers, hence few physicians are men.
20. Government is essential to civilization; the Soviet system is government; accordingly the Soviet system is essential to civilization.
21. You must have handed me a paper; for all the members of the class handed me a paper, and you are a member of the class.
22. To trick the enemy is laudable; but to trick the enemy is to deceive; hence to deceive is laudable.
23. An all-powerful being can do anything; now since God cannot make a man without a spiritual soul, He is not all-powerful.
24. When Charles Lamb said he would not admit that two and two are four until he was advised what use might be made of the statement, what fallacy did he direct attention to?

25. Some reasoning is false
This is some reasoning
∴ It is false.
26. Why are white bears more ferocious than black bears?
27. The purpose of punishment is either to protect society or to reform the criminal; but punishment does not protect society; hence it reforms the criminal.
28. "Theft is a crime; theft was encouraged by the laws of Sparta; therefore the laws of Sparta encouraged crime."
29. Fifty dollars were contributed by the men. There were ten men; hence the sum collected was five hundred dollars.
30. He who deliberately kills another should suffer death; a soldier deliberately kills his enemy; consequently for this act he should suffer death.

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PART II
INDUCTIVE LOGIC

CHAPTER XXIV

INDUCTION A PART OF LOGICAL DISCIPLINE

WERE the purpose of reasoning merely to reach valid conclusions a study of Induction would hardly fall within the scope of Logic. But valid conclusions that are not also true have little right to be called logical. Indeed they are with more propriety called illogical. Much attention must be of course be given to the rules by which we advance from accepted truths to whatever new and important things they imply, yet the question of how such truths come to be accepted should not be altogether neglected. Thought has matter as well as form; the two elements condition each other, and it takes both to interpret reality. Neither terms nor propositions can be properly handled without an understanding of their matter, their meaning, their implication; and a purely formal treatment of inference would be even more unsatisfactory. We found it necessary to consider at length the subject of material fallacies because in many instances conclusions that are validly drawn must be rejected on account of unsound premises. If, however, logicians are consistent in studying the misinterpretations and false assumptions that vitiate inference from the start, they are rightly concerned about the source and value of data upon which a solid

structure of truth may be founded. How to discover fallacies is in fact less vital to the science of Logic than how to find adequate premises—the problem that a study of Induction aims partly to solve.

THREE SOURCES OF PREMISES. The statement that reasoning is the application of a general rule to a particular case would have little meaning unless the rule in question were understood to carry the force of a law of thought corresponding to the nature of things, unless, more simply, the rule were true. In the structure of the syllogism a rule of this kind holds the place of the major premise; accordingly, our inquiry will have more direct reference to those propositions in which a predicate is affirmed or denied of a logical whole. Truths of this character belong to one of three classes: they are either (a) axioms, (b) universal propositions that are not self-evident, or (c) conclusions based on judgments of the (a) or (b) type. It hardly needs to be pointed out that the premises in class (c) may be derived by immediate as well as mediate inference. Premises belonging to class (a) are called *analytic* propositions because they have their source in an analysis of the subject or predicate concept, because in other words a complete understanding of either term compels assent to the necessary relations of both. Self-evident or axiomatic truths, such as "The whole is greater than any of its parts," or "Every effect has a cause," are the best examples of these. The premises included in class (b) are *synthetic* judgments in which the relation of subject and predicate can be known only through experience. Propositions of this sort are the specific products of Induction, the results of generalizing particular observations. They are familiar to us as the laws

of the natural sciences, the principles of art, and the more or less probable maxims that seem to satisfy for many practical purposes in life.

INDUCTION AND GROWTH IN KNOWLEDGE. Some light may be thrown on the nature of Induction by calling attention to certain features of intellectual development. The chief fact of importance in this regard is that with reference to a given subject our knowledge, as it grows, tends to crystallize into the concept, that, in other words, thinking which at first is difficult and complex, involving inference and judgment, may afterwards assume the easy and simple form of intuition. This enrichment of thought takes its rise from a stage in which reasoning is necessary to understanding. Thus if the subject "Faithful employees" were being discussed, one might find it impossible to see at a glance that "Faithful employees should be pensioned." There would be need, then, of supplying an argument in support of the statement; but when this was done, and when, as by repetition, the argument was thoroughly assimilated, the statement could compel assent by itself. So it happens that reasoning, once indispensable, becomes superfluous and as soon as it ceases to serve its purpose of supporting a judgment it drops away altogether. Accordingly, for the individual and for those who think with him judgments themselves acquire all the force that was orginally exercised by a process of inference.

In a further stage of intellectual growth a similar change occurs. So long as there is the least difficulty, the least hesitation in linking a predicate with a subject, knowledge requires to be set forth in a judgment. Since, however, assent to a proposition is never given unless the relation of subject and predicate is seen to

be under the circumstances necessary, persistent thinking about the relation stresses the necessity and has the effect of fusing the two elements, so that the predicate comes to take its place as part of the content of the subject and thereafter the subject does not enter consciousness without bearing the predicate among its cluster of attributes. Thus, the predicate "deserving of a pension" might in consequence of much reflection be merged into the subject "faithful employees," which would from then on carry this along with its other meaning; for when the formal expression of attribution is no longer necessary judgment falls into disuse.

Now in connection with this phase of thought-progress, featured, as we have just seen, by the dropping away first of reasoning and then of judgment, Induction may be said to play the part of furnishing attributes for concepts. The mind does not stop at laws or principles but uses them as steps towards intuitions. For instance, new meaning was added to our notion of water by the discovery that it is composed of hydrogen and oxygen: and modern investigation changed the whole idea of the nature of sound, heat, light, and electricity by establishing that these phenomena are modes of motion. If our knowledge were perfect all the attributes of a thing would be included in its concept, and we should understand it not only in itself but also in its various relations; that is, we should know its constitution, why it exists, how it originated, and what it can do. But perfect knowledge is never attained, and in order to fill out our concepts we are impelled to seek missing attributes by having recourse to the study of nature. In the pursuit of this study we arrive at inductions, which are consequently the chief means of enriching our ideas.

INDUCTION AND CONCEPTION. Considered as a process, then, Induction is of the same nature as Conception. Through Induction as well as through Conception the intellect grasps the essential qualities of a thing, only in the case of Induction, the qualities, instead of going under the generic name of essential, are more particularly described from the point of view of their causal relations. A thing is explained by its nature which is ultimately the *reason* for all that it is or does; hence to discover the essential qualities of a thing is to reveal it in some phase of producing or being produced, determining or being determined, causing or being caused. For example, when it was found that diphtheria is due to the presence of a specific bacillus, the bacillus itself, although it might previously have been known in respect of other attributes, acquired an added meaning, as cause; and likewise the disease, vaguely understood before, received fresh characterization as an effect with a definite origin. So it is with all the rules and maxims arrived at by Induction; the relations they express can always be interpreted causally. Even such a universal as "Man is mortal" carries the implication that the predicate is dependent on the subject. Indeed the peculiar force of judgments in this form—as well as in the hypothetical form, "If a being is a man, that being is mortal"—comes from the fact that the attribution of the predicate is made on account of something which lies in the nature of the subject. Thus, "mortality" is asserted of "man," seeing that within the content of the concept "man" there is the note "living organism" of which mortality may be regarded as a property. The point recalls the saying of Aristotle that the middle term is itself the "reason" or "cause"

of an inference; and perhaps the point would become clearer if our example were given in the form of a complete syllogism: All living organisms are mortal; Man is a living organism; therefore, Man is mortal.

Since Conception and Induction are one in nature they both involve the same processes, namely, abstraction and intuition. Moreover, both deal with the same material, that is, objects of sense experience. The qualities that come to us through perception have no stamp of value upon them beyond their significance as individual attributes: what they are in their highest relations and how far they are necessary to the specific constitution and activity of the things that possess them are questions that require intellectual study. In forming the concept the intellect considers all the characteristics of a class with a view of discovering those that are essential. As it weighs each note it withdraws (abstracts) attention from any that is decidely accidental or non-essential and leaves the remainder to be seen (intuited) in the new light of constituting a complete essence. Here of course there is no play of reasoning save only to the extent that the problem of abstraction (separating the essential from the non-essential) has sometimes to be solved by argumentation rather than by simple judgment.

In the formation of inductions abstraction is employed for a different purpose; namely, to withdraw attention from phenomena that do no enter into a given causal relation. Any difficulty about finding the effect of a known cause or the cause of a known effect arises from the presence in the first case of several possible effects and in the second of several possible causes. Evidently all these possibilities should

be carefully weighed. The point to be noted however is that as soon as a connection is discovered to be merely apparent it is thrown out of consideration—a proceeding which, though usually called elimination, is in all strictness, abstraction. Naturally the elimination must continue until one of the possibilities stands revealed in its true character of cause or effect. For example, if the members of a family were taken seriously ill shortly after dinner it would be reasonable to suppose that they were poisoned. A hurried examination might in fact indicate the action of a drug. No doubt there would be questions about the motive of the crime—if it was a crime—the chance of two or three different poisons having been used, the previous condition of the patients, etc., and each of these inquiries would call for the application of induction. But for the sake of simplicity the illustration may be restricted to the problem of discovering the kind of poison, on the assumption that only one drug was employed and the family was in perfect health. Then the induction would proceed by separately testing each item of the menu. In the course of the investigation what was found to be chemically pure would at once lose interest, that is, in accordance with the meaning of abstraction, attention would be withdrawn from it and the search would go on until some article of food or drink revealed the presence of a noxious drug. Following immediately upon the isolation of the drug there would be intuition of it as the cause of the illness, and this intuition is the chief factor in induction. To recognize the drug as cause is to universalize the experience; for such recognition cannot exist except on a previous understanding

of the causal relation, which, of course, is universal in character.

INDUCTION AS THE SOURCE OF UNIVERSAL LAWS. It is commonly said that through induction the mind passes from the data of sense experience to universal laws. This statement may easily be interpreted to mean too much. It does not mean that the universal is taken out of sense experience by way of inference, for the universal is not latent in the particular objects of perception as one truth is latent in another. The fact is that an inquiry which aims at the formulation of a law must begin with a general understanding of what the causal relation in question is; a problem of induction is invariably approached with the conviction that a given effect will be found to have a cause and a given cause an effect. In other words, the phenomenon which is singled out as the missing term of a connection is simply an instance of the universal that is in the mind beforehand. When, for example, we ask, "Why do bodies expand?", the question implies that all bodies do so, inasmuch as expansion is given the name of effect, and to call it an effect (that is, to say it is caused) is the same as universalizing it. But if we are seeking the origin of a phenomenon already universalized by virtue of calling it an effect, and if through observation we discover a fact which explains its origin, the intellect at once intuits this fact as the cause and is forthwith in possession of universal knowledge. The gist of the matter is that one term of a necessary connection, namely, the effect, is universalized before the inquiry begins; and if this is so, the other term, the cause, is also universalized from the beginning, though it cannot be defined until a particular instance of it is disclosed by sense exper-

ience. We employ induction for the purpose of seeking a sufficient reason for a phenomenon, and the moment we find it the connection is definitely completed and we are in possession of a universal law. Thus, if the expansion of a piece of iron is regarded not merely as an individual fact, but as an effect, that which explains it, namely, the application of heat, must stand out as something more than an individual fact, must indeed take on the character of a cause, the complementary term of a necessary connection. Accordingly, the mere discovery of heat as cause is warrant for the formulation of the law that Heat will in similar circumstances expand iron.

INDUCTION AS PROCESS AND AS METHOD. Any change which is featured by some sort of unity or continuity may be called a *process*. The name is of course more aptly applied to a simple change, but it also denotes a complex change the components of which are so closely related as to constitute one transaction. *Method* signifies the systematic arrangement of the steps that go to make up a complex process. From these definitions it is easy to see that induction may be viewed as both a process and a method. By comparing it with conception we were able to show that it has the essential characteristics of a process. Moreover we were able to bring out the fact that reasoning is not one of these characteristics, and that therefore induction cannot be looked upon as the reverse of the process of deduction.

However, to consider induction as a process only, would be to treat it too broadly. To say, for instance, that abstraction is a prime factor in discovering a cause or an effect is to cover with a word a group of important details. How to begin abstraction, how

to control it, and how to give it value for the purpose in hand, are questions which should not be overlooked. Hence it will be profitable to study induction as a method, that is, to consider the steps which an investigator must take in order to arrive at universal truths based on experience. But before entering upon this study it is advisable to have a clear idea of the methods generally employed in thinking.

QUESTIONS

1. Give a reason for considering Induction a part of logical discipline.
2. With reference to the source from which they are derived how would you classify the major premises of standard syllogisms?
3. What is meant by saying that intellectual knowledge tends to crystallize into the concept?
4. Explain the two stages in this development.
5. In what sense may Induction be said to furnish attributes for concepts?
6. Show that such a general truth as "Man is mortal" carries the implication that the predicate is dependent on the subject.
7. Explain Aristotle's statement that the middle term is the "reason" or "cause" of an inference.
8. What processes are involved in Conception and Induction?
9. For what purpose is abstraction employed in Conception? In Induction?
10. Illustrate the use of abstraction in Induction.
11. When it is stated that "through induction the mind passes from the data of sense experience to universal laws" are we to understand that the universal is taken out of sense experience?
12. How is the universalizing of particular phenomena accomplished?
13. Define a process; a method.
14. May Induction be regarded as both a method and a process?

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CHAPTER XXV

METHOD IN GENERAL

THE fact that thought takes two directions—advancing from the simple to the complex, or reverting from the complex to the simple—is a matter of common knowledge. Any case of conception or inference would under close scrutiny exhibit a prevailing tendency one way or the other. But the character of such movements is better illustrated by the more complicated forms of reasoning. We have seen (p. 237) that in a pair of conjoined arguments the conclusion of one syllogism is always a premise of the other. Since the dependent or episyllogism proves a proposition by means of a premise that is established through the prosyllogism, the later contains the reason or cause of the former and is by comparison simpler and more general. Consequently, *if in a chain of reasoning the mind is engaged first with the prosyllogism, the movement of thought is said to be forward and the method is Progressive or Synthetic; if on the other hand the mind deals first with the episyllogism, the movement is reversed and the method is Regressive or Analytic.*

ANALYTIC AND SYNTHETIC SCIENCES. A science may be distinguished according to the method principally employed in its pursuit. From this point of

view sciences are said to be (A) Synthetic and (B) Analytic.

A. In the synthetic sciences the movement of thought is chiefly progressive, that is, investigation proceeds from the simple to the complex, from the general to the particular. It must, of course, be understood that the step forward is from the *logically* simple to the *logically* complex. For instance, from the idea of God as the necessary being we pass to the notion of His immutability, although the one attribute is in reality as simple as the other. Immutability is logically complex, because, since it is proved by means of the concept "necessary being" it carries that meaning along with its own. Most frequently, perhaps, the advance in thought is from a logical whole to its logical part, that is, from genus (as cause) to species (as effect). This (deductive) method is applicable to every syllogism considered in itself, but not always to syllogisms as they are conjoined; hence even if a chain of syllogisms is of the regressive type, the reasoning within each link is progressive. The ground for this statement lies in the fact that the premises of a syllogism always contain the cause of the conclusion. For example, seeing that "sentient" is a characteristic of "animal" (logical whole), it must be a characteristic of "man" (logical part); the fact that "man" is an "animal" is the cause of his being "sentient." Thus, unlike a physical whole, a logical whole is simpler than its parts.

From what has been said it will be readily understood why the synthetic sciences are also called deductive, abstract, and rational. All these names are variously applied to General and Special Metaphysics, to Ethics and to Pure Mathematics. Natural Theol-

ogy, a branch of Special Metaphysics, affords a good illustration of the progressive method. In this science although the first step is to establish the existence of God by means of proof based on experience, every succeeding step is deductive. Beginning with the fact that there exsists a First Cause or Necessary Being, investigation proceeds in a synthetic way to fill out and enrich the idea of the Deity. The eternity of God, His omnipotence, His omnipresence, His omniscience, His love, justice, mercy, wisdom, and indeed all His other attributes, are derivable from the simple fact that He is. Perhaps a more familiar example of a synthetic science is Pure Mathematics, in which from a few general principles or axioms a systematic body of particular truths is built up.

B. An analytic science employs for the most part the regressive method. Its chief concern is to study experience with a view of learning the causal relations of phenomena. In contrast with a synthetic science its aim is to furnish the premises from which deductions may be made. Accordingly, the advance in thought is from the complex to the simple, from effect to cause. A thought movement of this sort may be brought about through reasoning alone, and in such case the argument is never anything but a regressive polysyllogism either completely expressed or in the abbreviated form of an epicheirema. When, however, the problem in mind bears upon the more distinctive work of the analytic sciences, that is, the derivation of universal propositions from particular instances, the process employed is induction and the method also goes under the specific name of induction. The process, it may again be noted, is not an inference but an intuition made possible by abstraction.

Sense perception carries into the mind physical wholes, the components of which are logical wholes, and it is to lay bare the logical wholes that induction is employed. For instance, in "man" there are the logical wholes "rationality and "animality" and these are set forth as a result of induction in the laws, "All men are rational," "All men are animals."

INDUCTION AND ANALYTIC METHOD. Since induction as a process deals first with concrete objects, the method it follows is of course analytic. To avoid confusion, however, the noun "analysis" should be used in a generic sense with "induction" as one of its species. Care should be taken to distinguish the analytic method which is known as induction from the analytic method which has been called "inductive reasoning." The term "inductive reasoning" is applicable only to the regressive method as employed in a chain of arguments, and it is an important factor not only in the analytic but also in the synthetic sciences. Doubtless in many cases a law arrived at through induction might suggest the working of a higher principle—as the laws of Kepler suggested Newton's law of gravitation; but the suggestion is never more than a hypothesis, and since the higher principle, no less than the proximate law, must be discovered by induction, it cannot be regarded as a product of inference.

In order to clarify still further the terminology connected with this subject it should be stated that while induction is an analytic *method* its product, a law derived from experience, is a synthetic *judgment*. An analytic judgment conveys a truth which is bound up in a mere understanding of its terms, whereas the truth of a synthetic judgment is derived from data of

sense preception. Plainly, then, the inductive method predominates in those sciences—the natural, physical, concrete sciences—which gather their material by means of observation and experiment.

GENERAL RULES OF METHOD. How to work within a particular field of investigation can be learned only by going into the field and working. As every science has its special purpose and its peculiar problems so it has its own technique, its own way of handling material. A good technique can be acquired only through habitual good thinking—determined, accurate, and imaginative dealing with a subject. Method comes of its own accord to one who keeps on the trail of his interests. Accordingly special methods can hardly be taught by precepts; nevertheless there are certain characteristics which are common to all valuable study and these may be acquired by observing a few rather simple suggestions. Traditionally the suggestions have been known as the Rules of Method, and the most important of them are the following:

I. *Take as a point of departure some familiar truth.* Thought is a vital process; it increases from within by growth rather than from without by accretion, and its expansion will be more perfect in proportion as the germ from which it starts has the vigor that thorough knowledge implies. What sort of truth should serve as a nucleus of development depends on the character of the inquiry: in the synthetic sciences advance is made from simple propositions, generally axiomatic, which are capable of wide application, whereas in the analytic sciences particular phenomena are the objects that must be studied to begin with.

II. *State the problem exactly; define all obscure*

or ambiguous terms; divide the subject into its smallest parts. If the first item of this rule is observed two things will be avoided: (a) wasting time in proving points that are obvious, or at least conceded; (b) straying away from the question at issue. The second item is essential to precision and is indeed a mere corollary of the first. In the third place the reason for making an exhaustive division is on the one hand to omit nothing that may be important and on the other to give each phase of the subject its due proportion.

III. *Proceed gradually, supporting each step by reference to a proximate principle or an observed fact.* This rule has a twofold purpose: (a) to avoid the danger of making unwarranted assumptions and (b) to render each step complete in itself while constituting it a point of departure for what follows. Thus from both a negative and a positive point of view observance of the rule insures against gaps in the reasoning.

IV. *Distinguish what is merely probable from what is true, and admit nothing as true which cannot be firmly established.* In adhering to this rule care should be taken to avoid what has been called the counter fallacy to Begging the Question, namely, demanding proof for what is self-evident or what has been already conceded. The question of how to deal with authority is pertinent in this connection: authority is worth only as much as the objective proofs that establish its credibility; it is worth that much, however, and once it has been proved acceptable its revelations should not be rejected because they cannot be *explained* on scientific grounds.

V. *Do not minimize much less conceal difficulties.* Open-mindedness, frankness, the will to think clearly, and an earnest determination to wrest truth from reality are essential to success in any investigation.

QUESTIONS

1. Distinguish between the analytic and synthetic methods of reasoning.
2. What is a synthetic science?
3. Explain the distinction between the *logically* simple and the *logically* complex.
4. Show that Natural Theology is a synthetic science.
5. What is an analytic science?
6. In what two ways may thought move from the complex to the simple?
7. Show that induction differs altogether from "inductive reasoning."
8. If induction employs the analytic method are the laws it establishes analytic judgments?
9. State the general rules of method.

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CHAPTER XXVI

THE INDUCTIVE METHOD

STEPS IN THE INDUCTIVE METHOD. From the observation of a particular phenomenon to the formulation of a law which explains it the progress of thought is often slow and tedious. During the course of an inquiry concerning the causal relation of things many issues have usually to be met. Questions of all sorts come up for consideration and their settlement may involve the taking of new evidence, the making of difficult experiments, the gathering of elaborate statistics, and the drawing of fresh analogies. Moreover, within the different fields of investigation there are proper ways of conducting a research which only the specialist is acquainted with. Plainly, then, the logician can hardly be expected to undertake more than a general examination of the steps which seem essential to every inductive inquiry. A brief description of these steps may serve to indicate the points that will be emphasized in our further treatment of the subject.

1. ASCERTAINING THE FACT TO BE EXPLAINED. There are two things to be noted in connection with this step. In the first place, a problem is not always presented with precision. Sometimes indeed, the terms in which it comes to us are misleading, as for instance, when a mere coincidence is put forth as

mental telepathy, a suicide as murder, an accidental fire as arson; and in such cases a restatement of the facts must be made. Sometimes, also, an occurrence which seems simple is really complex, and the phenomenon which needs explanation must be isolated before serious investigation can begin. In the second place, the phenomenon that is isolated should not be regarded as a fact of ordinary observation; it will not serve as the starting point for induction unless it is understood as a *cause* or an *effect* in necessary connection with another phenomenon yet to be discovered, unless, in other words, it is universalized from the outset.

2. THE FORMATION OF A HYPOTHESIS. This step marks the beginning of the process of abstraction. With the fact in question clearly before the mind as cause or effect, various ways of explaining it may be suggested. Such provisional explanations are called hypotheses. Without a plausible hypothesis induction cannot proceed, but it is also true that the next two steps can be taken with reference to only one hypothesis. If there are several suppositions, that which is most probable is chosen as a basis for research; the others may be either totally rejected or held in reserve.

3. DEDUCTION FROM THE HYPOTHESIS. Since a law is simply a verified hypothesis, a hypothesis may be regarded as a tentative law. By studying it from this point of view we can infer its specific application and know exactly what should be looked for if it were in operation. A deduction thus obtained has the universal character which belongs to every truth, and as a necessary consequence of the hypothesis it is pre-

sumably identical with the phenomenon to be explained.

4. TESTING THE DEDUCTION. The fourth step is an attempt to confirm this presumption, for a hypothesis is verified when an observed fact can be recognized as a particular instance of it. If the fact does not square with the deduction the hypothesis must be set aside in favor of another supposition. When the cause or the effect for which a reason is sought is successfully identified with the consequence of a hypothesis, the hypothesis itself may be formulated in terms of a law.

ENUMERATIVE INDUCTION

Before closing the general discussion about induction it is necessary to touch upon the method of enumeration as a means of arriving at universal propositions. The method was set forth with considerable detail by Aristotle who gave it a name that Latin scholars translated by the word "induction." Since he applied this name to no other mode of generalizing from particulars he is sometimes erroneously said to have recognized only this sort of induction. The plan of adding instances in order to obtain information about a collective whole can yield no more than an enumerative universal which, as we have seen, is not a true universal, and may not be used as a major premise without committing the fallacy of begging the question. Now it is certain that the author of the *Dictum de Omni et Nullo* understood the difference between a true and an enumerative universal, and it is hard to entertain a doubt that he was thoroughly acquainted with the manner in which both are formed. There is, moreover, abundant proof that the Scholas-

tics, the most reliable interpreters of Aristotle, far from regarding enumeration as the sole method of induction, placed it in its proper position as subordinate to scientific induction which, however, they called the "proof from experience."[1]

THE INDUCTIVE SYLLOGISM. The device Aristotle employed to show the term relations in the enumerative process is generally known as the Inductive Syllogism. This name, however, is misleading; for counting means no more than a succession of judgments, and the substitution of a single collective term in place of its summarized instances is at most immediate inference. Aristotle described the semblance of argument he had in mind as *"proving the major term of the middle by means of the minor."* His example together with a scheme of the terms will bear out the description:

S is P	Man, horse, mule, etc., are long-lived
S is M	Man, horse, mule, etc., are all the bileless animals
M is P	∴ All the bileless animals are long-lived.

This arrangement of terms is evidently based on the principle that what can be affirmed (or denied) of all the parts may be affirmed (or denied) of the whole. Although this principle bears some resemblance to the *Dictum de Omni et Nullo*, it should not receive a syllogistic interpretation; it is a mathematical axiom which merely guarantees the validity of a summarization. It throws no light on the important question of how—whether essentially or non-essentially—the given characteristic is or is not connected with the various parts, and until this question is

[1] Cf. Joyce, *Principles of Logic*, 3d ed., pp. 227–231; and Coffey, *The Science of Logic*, Vol. II, pp. 32-37.

answered there is no possibility of a real scientific law. In a regular deductive syllogism S, the catalogue of "parts," would be the minor term; in the scheme it holds the place of the middle because it furnishes the *reason* for the "induced" enumerative proposition. A close examination of the inductive syllogism will show that the minor premise merely states the result of counting, and that the conclusion is simply the major premise over again with a collective term, instead of an equivalent itemized list, standing for the subject.

ENUMERATIVE INDUCTION PERFECT AND IMPERFECT. The method of enumeration is said to be *perfect* when all the instances have been summarized, otherwise it is called *imperfect*. It is evident that perfect enumerative induction will give us certainty; but it would seem that when the counting is incomplete nothing whatever should be said about the remaining items. If counting alone is the process involved, the investigation ends where the counting ceases. We have no right, for instance, to assert on a basis of mere enumeration that since three-fourths of the apples in a barrel are ripe, all are ripe. When we make this "inductive leap," as is frequently the case, we do so on an assumption that is quiet apart from, though it dominates, the process of enumeration; and we have really gone over into induction proper. Counting may lead us to regard a quality as typical, but the reason for so regarding it is independent of counting. Moreover, even if a quality is supposed to be typical further counting will not help to verify the supposition. It has been said that although incomplete enumeration fails to give us certainty it furnishes us with

a greater or less probability; but this statement is true only in the sense that while we pile up the number of positive instances the possibility of meeting exceptions, or negative instances, decreases. Probability thus reached does not tell us what to expect; yet *if* we expected to find negative instances the circumstance of their non-appearance strengthens the probability.

THE VALUE OF ENUMERATIVE INDUCTION. Even when counting is complete it does not give us scientific knowledge. A characteristic that is found to belong to every individual of a class may be no more than an inseparable accident. The fact that the parts enumerated are species rather than individuals makes no difference, since the characteristic might be connected essentially with one species and accidentally with another; there would be no way of telling. An insurmountable defect of this method, therefore, is that it can never assure us of the causal relation between a subject and predicate; it can never acquaint us with the nature of an object, for the nature of an object is not known until we ascertain, independently of complete experience, that a given predicate does or does not necessarily belong to it. On the other hand, the chief value of the enumerative method lies in its power to suggest a causal relation. The condition that two phenomena (subject and predicate) are always or very frequently connected seems sufficient ground for entertaining the hypothesis that they are causally related. Inductive enumeration, then, is not altogether worthless from a scientific point of view; it is at least a valuable aid to induction proper.

QUESTIONS

1. Name the steps of induction.
2. What feature should a phenomenon possess in order that it may serve as the starting point of induction?
3. What is a hypothesis? Show that the selection of a hypothesis is a process of abstraction.
4. Explain the function of deduction in the inductive method.
5. In what does testing the deduction consist?
6. Is it probable that Aristotle was not aware of the way in which genuine inductive laws are established? Give a reason for your answer.
7. Give the scheme and an example of the so-called Inductive Syllogism. In what words did Aristotle describe this sort of "argument"?
8. State the "principle" on which this "reasoning" is based.
9. Show that the Inductive Syllogism is a Begging of the Question.
10. Distinguish between Perfect and Imperfect Enumerative Induction.
11. If the counting is incomplete may we make the "inductive leap" concerning cases not investigated?
12. How far is probability supported by incomplete counting?
13. If the counting is complete do we possess certainty? If so is the proposition that expresses this certainty a scientific law?
14. Give a brief estimate of the value of enumerative induction.

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CHAPTER XXVII

CAUSALITY

Although the word "cause" has been used quite freely in the preceding pages there is little danger that its true meaning has not been grasped. The ordinary notion of causality is fundamentally correct and will survive every attempt to explain it away. As commonly understood *a cause is that which originates something, that from which a positive influence goes forth to make a thing what it is in whole or in part.* This idea is the only guarantee we have for genuine thinking, the only means by which the isolated facts of haphazard experience can be gathered together into an ordered universe. The aim of all intellectual endeavor is to "know things by their causes." Moreover, the child's questions about who, what, and why, differ in no essential respect from those of the philosopher; back of them in either case there is the same consciousness of a discoverable reality, the same demand that the answers shall tell of a positive influence at work.

KINDS OF CAUSE

Now what more particularly may this *positive influence* be? Aristotle answered the question by distinguishing between four chief kinds of cause, two of them extrinsic and two of them intrinsic with reference to the effect. The two extrinsic causes are called

final and efficient; the two intrinsic, formal and material.

1. FINAL CAUSE. A final cause is the positive influence exerted by the idea of him who conceives the nature of the effect. It is the plan, design, purpose, or end for which the effect is brought into existence. Thus, the final cause of a locomotive is the inventor's notion of a device for rapid transportation; the final cause of mobilizing an army is the purpose of doing battle; the final cause of a problem play—the factor which controls the selection of incidents—is the lesson it proposes to teach.

2. EFFICIENT CAUSE. An efficient cause is the actual power, physical or spiritual, which brings a thing or event into existence. The effect of an efficient cause is always a new entity or a new state, a creation or a change. Needless to say creation in its strict sense is attributable only to the First Cause, God; secondary causes through the nature they are endowed with can do nothing except modify things that already exist. Even the human intellect is the efficient cause of its products, concepts, judgments, reasonings, merely in the way of elaborating them from the data of sense experience. Likewise, physical efficient causes are engaged simply in changing to a greater or less extent the objects with which they come in contact. With regard to the action of secondary causes, then, it should be understood that the change itself is the effect, the new "thing." A chemist, for example, does not create a substance when he forces elements into a compound, for the mass of the compound is exactly the same as the mass of the elements taken together, and consequently there exists in the compound something which was in the

elements—an abiding something which can also be the subject of further transformations. The efficiency of secondary causes, therefore, is never more than partial, and unless this limitation is kept in mind, the proper interpretation of scientific laws cannot be given.

3 and 4. FORMAL AND MATERIAL CAUSE. The distinction between matter and form is one of the commonplaces of everyday thought. People are constantly noting the differences of form when the material of clothes, houses, furniture, etc. is the same and the differences of matter when the form is the same. In every effect there are two constitutive elements both of which are properly called causes since they contribute to its being and are responsible for something in its make-up. As influences of a positive sort these causes, formal and material, are complementary to each other; and as logical terms they are correlatives, that is, the one cannot be understood except with reference to the other. The formal cause imparts being to the effect by shaping or determining the matter; the material cause imparts being to the effect by furnishing what is shaped or determined. A formal cause coalescing with a material cause constitutes the effect, the formal cause giving the effect its specific character, the material giving it the wherewithal to be specified.

From these definitions it will be seen that a formal cause is the active, a material cause the passive, principle lying in an effect: thus, making a gesture is an effect which requires two intrinsic causes, namely, the movement as such, and what the physiologists call a "disposition" in nerves and muscles. The disposition would be there, would be real, even if it were never

actualized; hence to regard a material cause as passive is not to think of it negatively or to minimize the importance of its being; it has the same rank as the formal cause with which it blends to make a third thing entirely different from either component. Since the material cause signifies a *disposition, potency, tendency,* and *capacity,* it conveys the idea of something inchoate, incomplete, and imperfect, something intended for further definition; accordingly its complement, the formal cause, implies *that which completes, fulfills,* and *perfects.* We are familiar with the distinction between formal and material cause from a logical point of view in the case of thought; we have seen, for example, that privative terms are positive in form and negative in matter, that propositions with the same matter have a fourfold relation on the square of opposition, and that an argument may sometimes be cast either into the hypothetical or the categorical form without altering the fundamental relation of terms. The distinction is also frequently made in a metaphysical sense with reference to substantial changes; when, for instance, hydrogen and oxygen are synthesized into water the forms which give the two gases their proper being and peculiar qualities disappear; but their material cause enters into the water as a component which coalesces with the new form to constitute a substance that differs altogether in its nature as well as its activities from the original elements.

Now it should be noted that every new thing is an effect in four ways; in other words, every new thing has each of the four causes: it is (1) brought into existence (2) for a purpose, and its being is made up of two components, (3) the formal, and (4) the

material cause. An effect is not explained, then, until *all* the reasons for its existence are set forth. Even questions heard in the street indicate a natural impulse to learn the different ways in which a thing originates; ordinary conversation is filled with such queries as, Why did he refuse the money? (final cause), What stained your clothes? (efficient cause), What style of play did they use? (formal cause), What was the flag made of? (material cause). Science and philosophy ought to show the way in dealing with every phase of a problem, but as a matter of fact workers in both fields are too often content with furnishing onesided explanations. For instance, the notion of final cause is arbitrarily dispensed with in some systems of thought, and in the dynamic theory of matter, now so generally adopted, the idea of material cause, the very thing in question, is lost sight of altogether. Sometimes, of course, the aim of an inquiry is legitimately restricted, and the mind finds immediate satisfaction in discovering a single cause; nevertheless for a complete understanding of an event, a knowledge of all the influences that contribute to its being is necessary.

CONDITION. When an effect has several antecedents it is not always easy to decide which of them is the cause, and even if such decision can be made there may be clear evidence that the effect would not have taken place unless, in addition to the cause, one or more of the other antecedents had been present. Now an antecedent which enables a cause to exert its influence is called a condition. A condition, then, does not directly contribute to the being of an effect: its function is to bring the cause to the point of working, to start it going, to direct it into the right channel, to

apply it to the proper place, to remove any obstacle that may prevent its operation. A condition may be indispensable for instituting a causal relation under special circumstances, or it may be indispensable under all circumstances; in the last case it is called a *conditio sine qua non.* Thus, fertilization of plants is brought about by the union of pollen and the seed within a pistil. Entrance of the pollen into the stigma of the pistil is therefore a *conditio sine qua non;* but the pollen may be carried to the stigma by the wind, by insects, or by artificial means, and consequently these are no more than ordinary conditions. Perhaps the relation of condition to cause is brought out more clearly in medicine than in most of the other sciences; for instance, the efficient cause of yellow fever is said to be a protozoön which, however, cannot infect the human body except through the bite of a mosquito; also, the familiar preventive measures directed against the inroad of various micro-organisms plainly emphasize the difference between cause and condition.

JOINT CAUSE. The presence of several antecedents does not always carry the suggestion that while one is the cause, the others are conditions. Sometimes two or more factors exert together a direct and positive influence to make a new thing what it is, and when this happens all the contributing antecedents taken as a collective whole constitute what may be called the Joint Cause.

There are *two types of joint causes one,* (a) *in which the participating members differ in nature from the effect they produce; the other,* (b) *in which their nature is the same as that of the effect.* In the (a) type we may distinguish the cases in which the contributing agents act all at once from those in which

they act in succession. Thus, in the formation of chemical compounds the causal elements operate at the same moment, as when hydrogen and oxygen cause the unlike effect, water; in less radical changes the causal elements act successively to produce the unlike effect, as when the static pictures of a moving film result in a sensation of motion. In the (b) type also the factors of a joint cause may work simultaneously or in succession. Thus, the colors and lines of a painting act all at once to produce a greater beauty than that which could result from any of them acting separately; on the other hand, the consecutive strains of a melody, each of which may be pleasing in itself, impart a distinct impression of beauty that is attributable only to all of them taken together. When joint causes act in succession their effect is said to be cumulative on the ground that considered as a single rounded result it is obviously due to the sum total of the contributing agents.

Of the foregoing illustrations those which involve perception would perhaps be the better for a somewhat further analysis. There is serious question, for instance, whether the successive pictures thrown upon the retina are the real cause of the perception of motion. They, or more proximately, cellular discharges in the brain, constitute rather a *conditio sine qua non* than the producing agent of the psychical event. Strictly speaking, the mind is the sole cause of every conscious process. However, from an objective point of view the stimuli may be regarded as the joint cause of the neurological effect which is indispensable as a basis for the mind's work of producing a perception; and at least with reference to this neurological effect our illustrations of joint cause will hold.

THE DOCTRINE OF PLURALITY OF CAUSES UNTENABLE. The opinion that there may be a plurality of causes, namely, that a given effect may be produced now by one and again by another *kind* of cause, is grounded on a denial of the reciprocal relation between cause and effect. Yet this relation is fundamental, for owing to the way in which the terms stand to each other we have a right to say either the same cause always produces the same effect or the same effect is always produced by the same cause. In the very idea of effect there is conveyed the meaning of a result that follows all the time; if, however, such a result is attributable to one agency in one instance it should be attributed to that agency and to no other in all instances. Cause and effect are simply the two terms of a necessary connection, and as the extremes of an unconditioned relation they must be the same wherever found. The nature of an effect derives its whole character from the nature of its cause; accordingly, only that which possesses the nature of the cause—in other words, only one kind of thing—is able to produce the effect. Death is commonly cited as an effect which can have different causes. But the difficulty of dealing with this particular example is that no one can describe except in quite general terms exactly what death may be, and until we know the essence of it as an effect we can never hope to discover its cause. A cause whether it be single or joint may coëxist with a variety of conditions at different times; but a plurality of conditions should not be confused with a plurality of causes. In the case of death we may reasonably contend that the ways in which it is said to be brought about are merely so many indispensable requisites for the working of an unknown cause.

CAUSE AS ANTECEDENT. There is hardly any doubt that the man in the street thinks of a cause as preceding its effect in point of time. In addition to this he always thinks of the cause as prior in nature; that is, as sending forth positive influence to originate the effect. We shall attempt to show that while the second of these views is acceptable the first cannot be maintained.

Logicians of the Empirical school, especially John Stuart Mill, contend that of two phenomena (or sets of phenomena), "the invariable antecedent is termed the cause; the invariable consequent, the effect."[1] In these words we have no more than the general statement that a cause always comes before its effect and an effect always follows upon its cause. But plainly the statement is open to a twofold interpretation which involves the distinction between priority in time and priority in nature. If the causal relation implies only temporal sequence, day and night are the cause of each other, for they are in turn the invariable antecedents and consequents of each other. Yet even Mill balked at such a conclusion. Although he formally rejected the notion of efficient cause, he seemed to sense that his invariable temporal antecedent would not supply its place, so he more carefully defined "the cause of a phenomenon to be the antecedent, or the concurrence of antecedents, on which it is invariably and *unconditionally* consequent."[2] Of course the word "unconditionally" in this revised definition introduces a good deal more than mere time association.

[1] *System of Logic*, III, V, § 3.
[2] *Op. cit.*, III, V, § 6.

Unconditional means necessary, and to say that one phenomenon *must* proceed another is to see something in the nature of the antecedent which exerts a positive influence to bring the consequent (a new entity) into existence. Terms, as we have seen, carry the mind out to things; moreover, the relations a term may have are never subjective in the sense that there is nothing actually corresponding to them in the thing the term stands for: hence the certainty that an antecedent is unconditioned does not settle upon us out of thin air; it is an integral part of our knowledge of the qualities the antecedent possesses. Our confidence that a given antecedent exists at all is no greater than our assurance that it is a producing agent—provided we see in it a necessary connection with the effect.

The empiricists affect to make no distinction between cause and condition; and yet they would have us understand that not every, but only an unconditioned, invariable antecedent has a right to the name cause. Their own distinction is significant and constrains one to ask, What is there in a necessary antecedent that does not exist in a *conditio sine qua non*, an antecedent which though not directly contributing to the effect is nevertheless invariable? Surely an intelligible answer can be given to this question. But would not the answer reveal the necessary antecedent as a real efficient cause, an agency which exerts a positive influence to bring about a new thing, a new event?

CAUSE PRIOR IN NATURE, BUT NOT IN TIME. We cannot conceive a connection with loose ends—a bond must needs unite two things—and if the connection is necessary one of its terms, the effect, is wholly dependent for its being upon the other, the cause. This sort of dependence makes the cause prior in nature.

Priority in nature, however, does not imply priority in time. True, an effect cannot begin until the influence proceeds from the cause, but, on the other hand, not until the effect has begun can the cause be said to work. The two phenomena are always simultaneous. The test of a cause, whether final or efficient, formal or material, is the force which goes out of it to determine the effect; and this force never acts for a moment without accomplishing something.

THE INFLUENCE OF EFFICIENT CAUSE. Each sort of cause exerts a positive influence to determine the being of an effect, and if there is any case in which such influence stands out most clearly it is surely that of efficient causality. Nevertheless writers continue to support the extreme empiricism of Hume who attempted (without succeeding, of course) to limit our knowledge to "vivid impressions," that is, sense perceptions in the absolute meaning of the term, and "faint images of these," that is, ideas "of which we are conscious when we reflect on any of those sensations and perceptions."[3] In a recent text-book on Logic there occurs the following passage: "It is obvious that the notion of there being a *power* in the stone (thrown against a window) which *produces* the effect is a very crude idea. In fact, it is on a level with the idea of the savage known as animism—the belief that everything is alive like himself, and it is simply a survival of that idea. For it undoubtedly comes from our *own experience of exerting effort* when we produce a certain effect, or from our *feeling of restraint* when something prevents us from doing a thing. Certain it is that we are here explaining one mystery by another, for, as David Hume pointed out, 'The

[3] *Inquiry concerning Human Understanding*, § 2.

connection between the movement of my limbs, and what I regard as the psychical cause thereof, is no more intelligible to me than that between their movement and the movement of the body which they strike.' And in any case, we cannot *see* or *perceive* the power of the stone which is supposed to break the glass."[4]

After pitying the plight of the remarkably dull savage who fails to achieve the distinction between the living and the non-living one may offer two reasons why the foregoing argument is unconvincing. First, we cannot ask for more certain knowledge of an influence going out from a cause than we get from "our experience of exerting effort" when we are self-active and from "our feeling of restraint" when our self-activity is opposed. In this subject-object experience awareness of force issuing from an efficient cause is given as straight as can be. In fact no writer has ever succeeded in describing the experience without using terms which involve the idea of efficiency. One may not, however, employ the only terms that will adequately describe this subject-object experience and then assert that the experience is not what from the description it seems to be, because the terms should not be taken on their face value. Second, we may further insist that "the connection between the movement of my limbs, and what I regard as the psychical cause thereof" is certain and self-evident, and is therefore no *less* intelligible "than that between their movement and the movement of a body which they strike," since this connection is also certain and self-evident. That "we cannot *see* or *perceive* the power in the stone which is supposed to break the glass" is hardly true.

[4] *The Principles of Reasoning*, by D. S. Robinson, p. 256; italics his.

For perception signifies a complex mental act in which thought combines with sense data to give us the thing in its nature as well as in its individual characteristics. Hence if we know a thing is so constituted that it will resist a given force and nevertheless perceive the thing undergo a change that only such force could produce we surely may be said to perceive the existence of the force as the change is unfolded before our eyes. It is a mistake to imagine that perception in a full-grown human being is simply a sensation pattern, the product of immediate stimulation, lacking altogether any imaginal or conceptual interpretation.

Although the mathematician may be satisfied to dispense with the notion of efficient cause in working out his problems of the interactions of plus and minus forces, the physical scientist who has any shadow of realism in his make-up cannot consistently indulge in the same refinement of abstraction. If there is a material world at all the bodies within it are not composed of "centers of force," mere points in space; they must as vehicles for the transfer of energy possess some kind of substantial reality. Moreover, it is this substantial reality to which the scientist habitually directs our thought when he employs the term "matter"—a term without which his descriptions would be meaningless inasmuch as they would have no extra-mental reference. Even in a simple explanation of the transmission of energy the idea of efficient causality plays an important part. For instance, an object-ball lying on a billiard table is known to have among other qualities that of inertia by virtue of which it would remain in the same spot forever unless it were acted upon. Accordingly the ball is familiar to us in its general character of a *quiescent* object. But when

having been hit by the cue-ball it undergoes a change of position we perceive in it a new general feature, we recognize it as a *moving* object. Now since our knowledge of the ball as an inert thing implies that force must enter it before its position can change, the mere perception of its motion *is* perception that such force has entered it. The impact of the balls would be explained scientifically by saying that the cue-ball lost while the object-ball received the same amount of kinetic energy. Energy, however, cannot be conceived as floating free in space, it is always tied up with something else; and in the case we are discussing the cue-ball by spending its energy upon the object-ball undoubtedly exerts a positive influence to produce the effect of motion in the latter.

THE LIMITED EFFICIENCY OF SECONDARY CAUSES. In science as well as philosophy much confusion of thought could be avoided if an investigator were always to remember that creation, the production of things out of no preëxisting material, belongs solely to the First Cause. Expecting secondary causes to do no more than effect changes, he would not only study an object before its change in order to understand what has been wrought in it, but would also consider the constitution of the agent in order to estimate how far it was productive. To exert an influence is to act, and the character of an action depends directly on the nature of the agent; to receive an influence presupposes a capacity, and the character of a capacity depends directly on the nature of the recipient. Obviously, then, a close examination of what may be called the setting of both cause and effect is required for an adequate account of the way in which natural phenomena are connected. For instance, the causal

relation established by the clash of two billiard balls is not completely explained by stating that the kinetic energy of the cue-ball produces the motion of the object-ball. On the one hand, the object-ball could not move in the precise way it does unless it were a piece of ivory with a perfectly spherical shape, and on the other hand the cue-ball could not carry kinetic energy the way it does unless it too were of the same material and shape. Thus, the roundness, smoothness, size, mass, in a word, the complete nature of both balls must enter into an accurate description of what has taken place. But things get their nature ultimately from the First Cause, and strictly speaking what they do as a consequence of having a specific make-up is also attributable to the First Cause. In saying this we are of course excluding all question of moral agency. What is important to bring out is the fact that in the physical order every created agent is merely an *instrumental cause* contributing its share towards working out the design of the Creator. A knife is a tool for cutting, but the effect called cutting would never occur unless the hard and sharpened substance of the knife carried energy that was brought to it from the outside. Similarly the nature that any object has may be regarded as an instrument by which the great store of energy put into the universe at the beginning of time is transmitted and transformed. To point out, however, that secondary causes are merely instrumental does not deny them efficiency. Their work is positive and definite; without it the First Cause could not produce the effect *in exactly the same way*, though, of course, He could produce it in a higher, better way. He does produce the effect in largest part by sustaining the nature of the secondary

cause and at the same time contributing to it all the energy it has. Accordingly, all substantial as well as accidental changes are due to the concurrent action of the First and a secondary cause.

PHYSICAL CHANGE IMPLIES A TWOFOLD CAUSAL RELATION. In view of the limited efficiency of secondary agents it is clear that what a physical object can do should be measured not merely by its own nature, including the energy it may carry, but also by the capacity of some other object to suffer a change called the effect. How the conditions pile up when we seek the proper restrictions of a statement such as, A knife is the (instrumental) cause of cutting! There are antecedents on the part of the knife: it will cut, if it is made of good steel, if it is not too dull, if it conveys sufficient force, if the edge is rightly applied; and on the part of the object to be changed: it can be cut, if it possesses some, but not too much, resistance to slide of parts—a knife will not cut a "perfect jelly" for it cannot overcome the resistance of such a substance, and it will not cut a "perfect fluid" for such a substance offers no resistance to work against. From these considerations it is evident that for purely mechanical purposes of exposition a causal relation between physical objects may be treated as a mere interchange of forces. But this does not do away with the need of thinking in terms of cause and effect; it simply means that we may regard every case of physical change as exhibiting a twofold causal relation. When, for instance, a knife cuts wood. we may say either the knife by conveying energy into the wood overcomes its resistance, or the resisting power in the wood impedes the motion of the knife. Yet this is by no means identical with saying that

the effect acts on the cause in the same measure as the cause acts to produce the effect—a simple logical expression of Newton's third law of motion, "Action and reaction are equal and opposite." The purpose of Newton's law was to furnish an axiom for the calculation of mechanical interactions conceived as specifically abstracted from their causal relations. When we speak of an effect we are thinking not of an object changed but of a change wrought in an object; only, in a reverse way, this whole object, viewed as a resisting agent, that is, viewed before or during the transaction, may also be said to produce a change in the nature of the thing which was asserted in the first place to carry the cause.

THE PRINCIPLE OF CAUSALITY

If we had full comprehension of an object we should know all its capacities and could predict what kind of influences are required to fill them out; in other words, we should know all its causes and likewise all their effects. But even when, as is invariably the case, our insight into a given nature falls short of full comprehension we still understand that nothing new could appear in it unless some force were brought to bear upon it. Perception of change, then, is the basis of the causal relation. Our conception of either term of the relation is possible only through an adequate knowledge of the other. Hence cause and effect are strictly correlative. It is necessary to think of the one when we think of the other, and this need gives rise to the self-evident proposition called the Principle of Causality.

The extensive application of this truth constitutes it a law of thought. Questions of origin, purpose,

essence, quality, material, shape, means, etc., are constantly presenting themselves, and each implies a searching after cause. Consequently in order to get anywhere with our thinking we are continuously forced to consider the causal relations of phenomena. We could not be sure of bringing our investigations to a satisfactory issue unless we were certain that such relations really exist, and the principle of causality is merely a formal announcement of this certainty. It adds nothing to the ideas of cause and effect; it is simply an analysis of them.

EXPRESSIONS OF THE PRINCIPLE. Any expression of the principle, then, will be an analytic proposition in which the meaning of the subject is seen to include that of the predicate. "Every effect has a cause," is the most familiar statement of the axiom. In this form it is easily reducible to the Law of Identity of which it is merely an instance; thus: A is A, that is, an effect is a caused thing; or "Everything is what it is," that is, an effect, a produced thing, is of such nature as to require a producing agent. In order to avoid the suggestion of a truism the principle had better be set forth in the judgment, "Whatever begins to be has a cause." "Nothing can come from nothing" is a negative expression of the law. When we have in mind the dependence of the effect on the cause we may use the form, "Every contingent thing has a cause"; or when our attention is rather fixed on the novel character of the effect we may say, "Every change or every new thing has a cause." The Necessary and Immutable Being, God, contains in Himself all the reason of His existence; this truth, although in accordance with the Law of Sufficient Reason, has no reference whatever to the Law of

Causality. Hence the latter is less extensive in its application; every effect has a sufficient reason in its cause, but God Who is without beginning is Uncaused.

Note.—Inasmuch as the principle of casuality is a law of thought it can have no exceptions. Consequently one is surprised to encounter the position taken by the writer of the following passage: "The statement that every *change* or every *event* has a cause is far from self evident. There is, indeed, no way in which it can be rationally established. It is conceivable that things might originate *de novo*. Events might be uncaused. At any rate, there is no *a priori* reason for refusing to admit the possibility that *some* events are uncaused."[5] The suggestion that "things might originate *de novo*" is not startling, for that is the only way in which they can originate. One suspects, however, that the author considers the phrase *de novo* as equivalent to *ex nihilo*. All that can be said about such utterances is that they are unintelligible. It is simply impossible to affirm the predicate "uncaused" of the subject "events": the First Cause alone is uncaused. We can hardly think of "Nothing" as feeling an urge to do something, or as somehow blossoming or bearing fruit.

QUESTIONS

1. What is meant by a cause?
2. Define and illustrate final cause.
3. Define efficient cause.
4. Can every efficient cause produce a completely new substantial being?
5. If your answer to the preceding question is negative how are effects of efficient causes to be distinguished?
6. Define formal and material cause.
7. Explain the statement that "to regard a material cause as passive is not to think of it negatively nor to minimize the importance of its being."
8. Show that formal and material causes are both positive influences.

[5] *Beginners' Logic*, by R. H. Dotterer, p. 308.

9. Give three illustrations of formal and material causes.
10. Show that every change has all the four causes.
11. What then is necessary to a complete explanation of phenomena?
12. Define a condition.
13. Define a *conditio sine qua non*. Give an example.
14. What is meant by a Joint Cause?
15. Distinguish between the two types of joint causes.
16. Exemplify both types.
17. Is the meaning of joint cause identical with that of a plurality of causes?
18. Show that the doctrine of a plurality of causes is untenable.
19. Is a plurality of conditions admissible?
20. What is the popular notion about the character of an antecedent? Is this notion altogether acceptable?
21. What is Mill's general definition of cause and effect?
22. Show that when Mill more carefully defined "the cause of a phenomenon to be the antecedent, or the concurrence of antecedents, on which it is invariably and *unconditionally* consequent" he employed terms which point to a positive influence entering into the production of an effect.
23. On the basis of Mill's general definition would a distinction between a cause and a *conditio sine qua non* be possible?
24. Show that while cause is prior in nature to its effect it is not prior in time.
25. Would you say that there is "a power in the stone (thrown against a window) which produces the effect"?
26. Show that in the subject-object knowledge imparted by "our experience of exerting effort" and "our feeling of restraint" we have immediate evidence of an influence going out from a cause.
27. Why is it hardly true that "we cannot *see* or *perceive* the power in the stone which is supposed to break the glass"?
28. Prove that an instance of the transmission of energy is simply a case of efficient causality.
29. Show that material bodies cannot be regarded as mere "centers of force."
30. What in general is the difference between the work of the First Cause and that of secondary causes?

31. Explain the statement that "a close examination of what may be called the setting of both cause and effect is required for an adequate account of the way in which natural phenomena are related."

32. Show that in the physical order every created agent is merely an instrumental cause contributing its share towards working out the design of the Creator.

33. Discuss the proposition that "every case of physical change exhibits a twofold causal relation."

34. Give three statements of the Principle of Causality.

35. Show that it is less extensive than the Law of Sufficient Reason.

36. Is it possible to think that a thing might begin to be without having a cause?

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CHAPTER XXVIII

THE UNIFORMITY OF NATURE

UNIFORMITY A PROXIMATE PRINCIPLE. In order to feel that the cause of a given effect or the effect of a given cause is not an isolated phenomenon but that its recurrence may reasonably be expected, we must get closer to the permanent realities of the physical universe than the principle of causality will carry us. Causality carries us far; relying on it alone we may arrive at general truths from individual cases. Simply to name a thing as cause or effect is, as we have seen, to announce that we have grasped one term of a necessary relation, and as this term is universal its correlative when discovered will also be universal. But as soon as we identify the universal extremes of an unconditioned connection we have reached a truth that has unlimited application. Accordingly the formation of valid inductions rests primarily on the principle of causality.

Now when in a particular instance we have successfully isolated the cause, let us say, of a phenomenon we are in possession of a universal truth which may be expressed in the proposition, "*A* as such is the cause of *a*." But we may go beyond this judgment; we may learn that *A* is either self-determining or itself determined. This additional knowledge is not derived from the principle of causality nor does it

affect the principle in any way. Whether *A* is free or not its relation to *a* is reciprocal; if *a*, for example, is an act of heroic charity it must issue from a free will—that sort of effect cannot be produced by any other kind of cause, and that kind of cause alone will produce that sort of effect.

Suppose, however, we are aware that *A* is a non-free cause, we may then assert that if or whenever *A* acts under similar circumstances it will always produce the same effect. In this judgment we discern a slight advance over the ordinary induction based solely on the principle of causality; we note the implication that if or when a particular class of determined objects represented by the subject should act under conditions such as have been observed they would not fail to bring about the same result. Reflecting further upon the nature of *A* we see that it stands not only for a single *class* but for the whole *order* of determined objects, and we have our way clear to announce the broader truth: *If any non-free cause produces a given effect in one instance, it will in all similar instances produce the same effect.* This is the Law of the Uniformity of Nature expressed in hypothetical form. As thus stated it is an analytic, self-evident truth, for the antecedent (the subject) signifies all that is involved in the idea of the consequent (the predicate).

But the principle of uniformity offered as a hypothetical truth, necessary though it be, will not serve the practical purposes of the investigator; for his aim is to formulate laws upon which he may ground reasonable expectations of the recurrence of phenomena, laws which will enable him to look forward to substantial results, laws, in a word, that *work*. Prop-

erly interpreted a hypothetical proposition does not carry the mind out to the external world; there is nothing in it which imports the existence of the antecedent and nothing, therefore, which gives the consequent the character of a fact. Thus, when we say, "If the sun shines tomorrow it will cause the wheat to grow," we do not predict that the sun will shine tomorrow. Evidently, then, the needs of the scientist demand that the principle of uniformity be stated categorically, for a categorical proposition as commonly understood does carry the mind out to the external world. However, the moment the principle is expressed categorically with a reference to reality it ceases to be a necessary truth and takes on the character of an assumption.

THE ASSUMPTION OF UNIFORMITY. An unconditional statement of the principle of uniformity will have some such form as: *All non-free causes are constant in their action, or A non-free cause will exert in the future the same influence it has exerted in the past.* The import of these and similar unqualified expressions of the law is to assert permanence in the physical order. They have the force of a prediction, and imply that what has happened will happen. The scientist who works with them may confidently plan for the future. And yet the principle of uniformity in its assertive form is a pure assumption.

To begin with, not even an assumption of uniformity can be entertained in respect of free causes. These may or may not recur. Perhaps it is right to say, "The days of chivalry are gone," yet it would also be reasonable to look for their return. A hero may never repeat; in the face of similar objective hazards he may at the critical moment decide upon a

less ideal course of conduct. On the other hand, an act of self-sacrifice outshining all the deeds of song or story may be performed tomorrow. With reference to the moral order, therefore, any dipping into the future will savor of speculation rather than scientific prediction.

The law of uniformity, hypothetically stated, assures us that if a non-free cause should act again it will do the same thing as it did before. This judgment would be true even if there never were non-free causes. It is of course self-evident that non-free causes exist here and now; their existence is directly *given* in elaborated sense perception. But will they continue to exist? An answer in the affirmative would be a judgment based on grounds not contained in the hypothetical expression of the principle, would be, in other words, a mere assumption.

THE BASIS OF THE ASSUMPTION. An assumption can serve no good purpose unless it has a reasonable foundation. Let us see what grounds there may be for the postulate of uniformity. In the first place, the question of uniformity regarded as a categorical generalization could not arise at all unless it were admitted that the physical universe is a product of creation. The function of scientific laws is to explain the order that is apparent in the universe. There could be no such order, however, were there not a Supreme Intelligence. As Newton said, "this most elegant system, consisting of the sun, planets, and comets, could not originate except by the design and power of an intelligent and mighty Being."[1] This proposition is not an assumption, but a truth which

[1] *Principia: liber tertius, scholium generale.*

can be established by reason independent of supernatural revelation. The matter and energy which have run a stupendous course of transformation since the beginning of time were brought into existence and sustained by the First Cause and have exerted no influence save only in concurrence with His almighty power. By studying the causal relations that obtain among phenomena we are able to learn something about the Creator's design, we are able to formulate the laws which bring simplicity and unity out of the elements of chaos.

Non-free causes are endowed with a nature nicely fashioned for doing one specific thing. They are simply instruments and as such require to be worked. In accordance with their constitution they are restricted to the mode of action imposed upon them by their Maker. Their existence as well as their activity is immediately dependent upon His will. They are here today, but will they be here tomorrow? Who knows? All we can say is that we have no reason to think that the purpose for which God designed the universe will soon be fulfilled. And this absence of a reason for predicting anything like proximate annihilation is the only foundation we have for postulating the continuance of the physical universe. The weakness of the foundation is obvious, yet there is nothing else upon which to build the assumption of uniformity.

LIMITATIONS OF UNIFORMITY. It would seem, then, that an unrestricted application of the principle of uniformity is unwarranted. There are at least two limitations of it which should be kept in mind.

1. In the first place, since even the continuance of the physical universe is quite problematical, we

certainly have no right to assert its permanence. There are, indeed, scientific data upon which to base an argument that it will come to an end. These are to be found in the doctrine of the dissipation of energy. It is a fact that whereas all other forms of energy easily pass over into heat, heat itself can be brought back into any of these forms only with the greatest difficulty. Consequently the reduction of energy to the form of heat is spoken of as "degradation." Furthermore, the availability of heat for the purpose of doing work depends on an inequality of temperature between parts of the same system. But since the universe is gradually settling towards an equilibrium of temperature there will come a time when all the energy of the universe will be unavailable, that is to say, there will come a time when no work can be done, when no changes can be effected, when no causal relations between phenomena will obtain. The scientist himself, therefore, faces a condition of things in which his laws will not be operative; and howsoever far away in the future this condition may be, it is evidently an obstacle to a sweeping application of the principle of uniformity.

2. The principle of uniformity is sometimes erroneously said to be the major premise of all scientific reasoning, as if the form of the scientist's thought were something like the following syllogism:

Physical agents will always do the same thing
This physical agent *A* has produced the effect *a*
$\therefore$ *A* will always produce *a*.

A glance at this form might lead one to suppose that the induction is not attained until the conclusion

is reached. But this is not true. The minor premise alone expresses the law; for independently of the major premise it announces that the *kind* of cause which produces *a* has been discovered. We have already seen that when we lay bare even *one* instance of the cause of a given effect we are in possession of both terms of a necessary connection, and we may express our knowledge by means of the formula, "If *A*, than *a*." This hypothetical proposition is the substance of the induction. It does not, however, carry us into the future. The added assumption of uniformity does that. Nevertheless to acknowledge that the assumption of uniformity enables us to predict that what has happened will happen is not to admit that the principle is the major premise of all scientific reasoning. Of course we may not say *A* will always produce *a* without postulating the uniformity, yet when we assert the minor premise we utter a truth which has considerably greater scientific value.

QUESTIONS

1. Show that the formation of valid inductions rests directly on the principle of causality.
2. Would the law of the Uniformity of Nature hold good in a world of free causes?
3. Explain the origin of the law.
4. Is the law as hypothetically expressed necessary?
5. Show that as categorically expressed it takes on the character of an assumption.
6. What is the import of a categorical statement of the law?
7. What grounds are there for the assumption that nature will continue to act as it has acted?
8. Even on these grounds may we assert continuance of non-free activity through an unlimited future?

9. May the principle of uniformity be regarded as the major premise of all scientific reasoning?

10. Show that scientific law is really formulated before the principle of uniformity is applied.

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CHAPTER XXIX

TRUTH AND CERTAINTY

PRINCIPLES AND ASSUMPTIONS IN INDUCTION. We have seen that for its beginning as well as for its subsequent steps Induction depends upon a few principles and assumptions—the laws of thought, the uniformity of nature, and, within special fields of research, suppositions which have a more limited application. These generalizations are both directive and corrective; they are not only incentives and guides to thinking, they are also checks upon it. There is, however, a difference to be noted in the results they yield. If an inductive inquiry is based altogether on principles it will lead to a true universal, provided errors of observation and fallacies of reasoning have been eliminated. If on the other hand an investigation is supported wholly or in part by assumptions it can be productive only of a probable truth. This is so because the doubt inherent in an antecedent will of necessity reappear in the consequent.

Thus the value of the several processes that enter into an induction should be estimated first of all by the character of their groundwork. Induction aims at the establishment of laws, propositions which exactly express the nature of things; but if investigations are conducted under the lead of assumptions rather than principles no laws worthy of the name

can be announced. As hereafter it will be seen that there are other sources of doubt besides assumptions it may be well at this point to consider in a general way how truth is related to Certainty and Probability.

THE TRUTH-BEARING ASPECT OF JUDGMENTS. In defining truth as the correspondence of thought with reality we should remember that not every such correspondence may be called true. A mere contemplation of the nature of things, for instance, does not raise the question of veracity at all; and although concepts adequately represent existing classes they do not carry the force of truth. Truth reveals itself only in judgments; hence it is never manifested except when there is need to insist that a formal act of correspondence between thought and reality is here and now going on. The problem of truth does not arise until a point is to be settled for either oneself or another, until in other words there is some hesitation in asserting whether a subject does or does not take a given predicate. Judgment, therefore, at least on the part of him who makes it, is always offered as the settlement of a difficulty. Consequently every judgment besides affirming or denying a predicate of a subject conveys in itself a claim to be regarded as true. This claim of course can be pronounced valid or invalid either on the self-evident character of the relation expressed in a proposition or by further reference to reality.

CERTITUDE. As commonly employed the term Certitude has both an objective and a subjective reference.

Objective Certitude denotes the necessity by which a thing is what it is, whether we are aware of the

necessity or not. As a rule this sort of certitude is called the reality or a certainty.

Subjective Certitude indicates a mental attitude towards the claim to be true that is put forward in a judgment. It may be defined as a state of mind in which one clings to a proposition on account of motives that exclude all prudent fear of error. In its strictest sense subjective certitude covers only such cases of firm adherence to a judgment as are based on sound objective motives, that is to say, on indisputable reasons for the necessity of affirming or denying a predicate of a subject. In a much looser sense, as we shall presently see, the term is sometimes applied to the firmness with which mere opinions, or probable statements, are held.

GROUNDS OF CERTITUDE. Certitude proper never wavers, nor is it ever blind; it brooks no contradiction yet at the same time is ready with a sufficient reason for the truth it maintains. This sufficient reason is sometimes called the grounds of certitude and sometimes simply evidence. There are two kinds of evidence, immediate and mediate.

Immediate evidence is another name for self-evidence or intuition. A proposition is immediately evident when its terms cannot be thought to have any other relation than the one expressed. Truth is seen directly through either intellectual intuition, as in the case of the laws of thought and analytic judgments, or perceptual intuition, as in the case of concrete facts of sense experience. Thus there is as much self-evidence for the statement, "The sun is shining" as for the axiom, "The whole is greater than any of its parts." Both these propositions refer us at once to reality where in the state of things as they are we see

the expressed relations—too simple, too striking not to be grasped. If with the reality before us we use the given terms at all we must use them in the relations announced, and this subjective necessity is only the counterpart of a manifest objective necessity. In propositions of this sort there is a force which compels our assent. Accordingly our attitude of certitude in their regard is easily explained; the possibility that their opposites might be true is unthinkable.

Mediate evidence denotes the reasons which support a truth. Propositions that are not self-evident should be regarded as assumptions unless they are rendered certain by proof. A sufficient reason for accepting such propositions may be found either in the data of immediate and mediate inference or in the grounds of induction. Hence a proposition is mediately evident not only when it is a conclusion validly drawn from one or more true statements but also when it is a generalization properly made from a knowledge of particular facts. As a motive for adhering to a judgment without fear of error mediate evidence fulfills its purpose because, since it is always either a process of reasoning or a case of induction, it can ultimately be grounded on principles that are self-evident.

Immediate and mediate evidence are always *intrinsic* to the proposition they directly establish. Such a proposition may, however, be itself a reason why we assent to further truth, and when this is the case the former in respect of the latter is called *extrinsic* evidence. Thus, the credibility of authority is established by reasons that constitute intrinsic evidence; but credibility itself—expressed in the proposition, "This authority must be believed"—is extrinsic

evidence for the truths authority may announce. Accordingly credibility, like all other truths that are the products of immediate and mediate evidence, is an item of *knowledge* in the restricted sense of the term, whereas a truth based on authority is always an item of *belief*.

KINDS OF CERTITUDE. In accordance with the sort of motive which supports the mind's firm adherence to a proposition certitude is said to be Metaphysical, Physical, or Moral. This division has an objective source, and consequently an objective value; for motives rest on evidence. and evidence, whether direct or indirect, is, as we have just noted, knowledge of reality.

1. *Metaphysical certitude derives its motive from a consideration of what is essential in things.* A judgment in which the nature of objects is the sole ground of comparison or analysis yields the evidence for this species of certitude. Thus if a predicate is found to lie in the predicable species, genus, differentia, or property its relation to the subject is seen to be necessary not as a result of observation but simply by reason of the ideas involved. This is so because the very nature of such predicates (essential attributes) precludes the possibility that they might be absent from their subject. In a process of resolving abstract concepts into their constituent elements the mind unfolds connections which are clearly independent of temporal or spatial relations; accordingly we are often able to announce truths about beings that do not, or may not exist—mere possible beings such as a Martian, a cyclops, pure space, geometrical figures. What may be affirmed or denied of subjects like these into which the accidents of experience do not enter

is understood to be either an integral part, or no part at all, of their essence. Motives of metaphysical certitude may be immediately or mediately evident; for instance, all the truths of pure mathematics yield metaphysical certitude; its axioms, however, constitute immediate evidence, whereas the conclusions based on these furnish mediate evidence. We may offer a few examples of truths that elicit metaphysical certitude (a) by immediate and (b) by mediate evidence: (a) Of two contradictory statements one must be true while the other is false, and vice versa; Things equal to the same thing are equal to one another: A child must have a mother; (b) A Martian could not weigh as much as an Earth-man; The angles of a triangle are together equal to two right angles; A thing that feels must have life.

2. *Physical certitude—a firm adherence to truths that concern existences and interactions within the physical order—is derived from either the immediate evidence of sense perception or the mediate evidence of inference and induction.* That the senses yield direct evidence about objects we are said to know through experience can hardly be denied. Although memory, imagination, conception, and immediate inference may, and doubtless do, contribute much towards the product of an act of perception, at least the purely sense portion of that product is the result of the mind's coming into positive contact with something not itself, namely, an external reality. This clash with reality guarantees objective certitude; for when the mind feels itself at work upon an object other than itself it has immediate evidence of that object's extra-mental existence.

Inductions cannot be employed as mediate evidence

for physical certitude until they are converted into scientific laws. Scientific laws have the force of predicting as well as explaining facts, and they derive this force from the Principle of Uniformity. Uniformity, however, is an assumption which we confidently entertain because we have no reason to think that God, upon Whose will the continuance of the universe entirely depends is about to bring the course of nature to and end (p. 343). Strictly speaking, then, we do not have unconditional certitude about the future. Nevertheless whatever uncertainty we may feel regarding the permanence of the physical order does not arise from ignorance, but rather from a thorough understanding of its constitution. We know that its agencies are non-free secondary causes, that, therefore, they must go on producing their effects if the First Cause wills them to do so. Their continued existence and specific activity are necessary as long as annihilation does not take place or a miracle is not performed. Yet if a miracle were performed that act of Divine interference would not shake our confidence in the future recurrence of phenomena according to established law. After the occasion for intervention had passed we should expect the forces of nature to resume their regular relations. There is in non-free causes a necessity we are obliged to recognize, and we distinguish this necessity from that which is called metaphysical by giving it the name "contingent." Hence we have a right to make predictions, yet only when we do so with reference to the Divine will. Thus we may not state absolutely, "The sun will rise tomorrow"; all we can properly say is, "Please God, the sun will rise tomorrow."

3. *Moral certitude is a firm adherence to truths*

that are concerned with the words and deeds of moral agents. From what has been said about the relative value of metaphysical and physical certitude it is clear that the mind does not adhere to all truths with the same amount of firmness. In other words, there are degrees of certitude and these are measured by the strength of the evidence. Furthermore, our motives for assent may be either theoretical or practical; they may look to the formulation of true universals or they may have in view a need of the moment, a choice of action here and now to be performed. Accordingly, while practical certitude may be entitled to the name—for when it exists we hold to a proposition without prudent fear of error—nevertheless we should not contend that it has the same value as theoretical certitude. This difference in the weight of motives should never be lost sight of, especially in a discussion of moral certitude. Moral certitude is brought about in three ways, but in only one of these —and in that not always—are there furnished motives for the highest type of adherence. The other two cases exhibit certitude in its broadest and weakest sense. Let us now consider the three modes in which moral certitude may arise.

A. Moral certitude with regard to facts we have not directly observed may be derived from an authority (a person, group of persons, or human document) whose credibility can be confirmed by sound judgment. A statement must be accepted as true if it is made by an infallible authority, namely, an authority that is manifestly incapable of deceiving or being deceived. Truth thus assented to with no prudent fear of error is said to be believed. The name "belief" is given sometimes to the truth itself and sometimes

to the act of entertaining it. Much of our *learning*, however, much of what we claim to *know* (in the broad sense of the term) comes to us from "hearsay" or reading and is seldom referred to as "belief."

Can human authority ever be proved to be infallible, that is, incapable of deceiving or being deceived? A negative answer would cast the shadow of doubt upon all the judgments that have ever been pronounced in courts of law, would render debatable every statement of fact that is set down in texts of history and science, would inject into social intercourse a constant and intolerable suspicion so that no one could consistently believe anyone else. To be sure, credulity is common enough and so is deceit; again and again not only individuals but whole communities have been induced to accept statements that were afterwards shown to be false. Yet these exceptions rather support than weaken the contention that under certain circumstances witnesses may be proved incapable of deceiving or being deceived; for in these very cases truth was finally ascertained by applying rational methods of investigation. Incompetency and insincerity do render a great deal of testimony doubtful or altogether worthless; nevertheless human authority would seem to be infallible when two conditions are fulfilled simultaneously: first, when it announces simple facts rather than interpretations of fact; and secondly, when it is cumulative, that is, when its strength comes from exact repetitions made at different times and in different places by many persons of different character, different grades of intelligence, different stations in life. Provided these two requirements are met no sane man ought to have a moment's hesitation in accepting the testimony.

Indeed belief in the tsetimony of a single person may be justified on grounds that are much more liberal; for if a man were known to be meticulously truthful he could not be conceived to speak falsely, especially when it would be against his interests to do so. Experience prevents us from admitting that deceit is theoretically possible if this possibility is founded on a supposition of practically impossible conditions: for certitude need not exclude all fear of error but only prudent, that is to say, reasonable fear; and there can be no prudent fear of error when the danger of making a false judgment is remote. In a subsequent paragraph we shall take up the question of belief on Divine authority.

B. Moral certitude may be arrived at by means of induction, and when this is the case it differs from physical certitude not only in subject matter, but also in degree. Facts within the physical order are the particulars from which we rise to the generalizations that furnish the motives for physical certitude. But we may also form inductions out of facts that lie in the moral order. By observing the conduct of men we can make suppositions as to the tendencies they manifest in their free relations with other men, and in some cases we can regard our suppositions as verified. Such verified suppositions (inductions) are the laws of economics and the social sciences, as for example: Men are not given to useless lying; A mother will defend her child; The drowning man grasps at a straw. These generalizations resemble physical laws not only in their origin but also to a considerable extent in their force. Since both are dependent on acts of free will neither is metaphysically necessary. Contingent necessity, however, is attributable to predic-

tions arising from both; for just as miracles do not diminish our certitude with regard to the recurrence of natural phenomena, so exceptions to inductions based on outstanding tendencies of human nature do not make us change our mind about the future conduct of men. Nevertheless the frequency of exceptions as compared with miracles seems to affect in a reflex way the character of the inductions themselves so that whereas physical laws are true universals, the laws of economics and the social sciences are merely moral universals. Furthermore these moral universals carry greater weight if they are derived from deep-rooted instincts, such as mother love, than if they are founded upon uniformities of behavior brought about by environmental influences such as legal enactments, religious observances or trends of civilization.

C. In its widest application the term Moral Certitude includes the firm adherence that is frequently given to highly probable opinion. A proposition to which there are comparatively few exceptions is a valuable instrument for explaining phenomena and is therefore entitled to be called a law. On the other hand a statement that has many exceptions can have little expository power and should not be regarded in the light of a principle. But although such generalizations are opinions rather than laws they may be so well grounded as to compel the mind's firm adherence and thus take on the character of practical certainties which for reasons of prudence one fears to reject. Proximate forecasts from a weather bureau, the advice of a skilled physician, warnings of crop failures, are examples of opinions it would be unreasonable not to follow.

BELIEF ON DIVINE AUTHORITY. The subject of

belief on Divine authority is so important and so frequently misunderstood that although what there is essentially to say about it might be inferred from our discussion of belief on authority in general, a brief treatment of some of its special phases may be profitable.

It is an inviolable rule of method that certitude about facts we have not ourselves observed can have no logical motive save the mediate evidence of sound argument which proves authority incapable of either deceiving or being deceived. Accordingly no other rule can be applied to the question of Divine authority. Whether it be a prophet or God Himself, as in the case of Christ, a person who claims to announce Divine truth must establish his right to be heard. This he can do only by working miracles or uttering prophecies. A miracle is always a fact of observation and a prophecy never deserves the name until it is verified. A miracle—and the same is true of a prophecy which is itself a miracle—could find no place in our thought, let alone in reality, unless it were conceived as adequate evidence of supernatural revelation. The regular phenomena of the physical universe are quite sufficient to reveal the existence of God and many of His attributes—all in fact that are required to establish the fundamentals of natural religion and the moral law. Were there then no supernatural truths to be known miracles would be merely a source of confusion; they are admissible and significant only as extrinsic evidence of special revelation. Of themselves they are simple facts of a physical sort appreciable by the senses—extraordinary, to be sure, but no more marvellous except for their rarity than the act of creation which is constantly going on.

This is not the place to prove that any given event in the past was a real miracle. We are considering the mere logic of faith. No one, however, can deny the possibility of miracles; God's in His heaven, and if it should come within the scope of Providence to impart more knowledge than man can achieve through the light of reason, the thing could be done. All we have to understand is that miracles are acts of God, new processes, and therefore literally new creations. Now anyone who admits the possibility of miracles must grant that they could hardly serve their purpose if they were more difficult to discern than other happenings. The evidence upon which we are asked to base our assent must plainly be commensurate with our power of knowing. In their very nature miracles can never be occult; they are necessarily more striking and consequently less liable to escape notice than common appearances.

It is clear, then, that we should pay no heed to a witness, even when he claims Divine authority, except on good rational grounds. But if he performs miracles in proof of his right to be heard we must acknowledge his Divine mission. Then what he utters is the very word of God, and truth which is recognized as coming in a special way from the Deity Himself compels adherence in the highest degree. Hence belief on Divine authority is accompanied by the strongest kind of certitude, for we should sooner think that our powers of reasoning could fail us than that the word of God should be false.

An objection to the point we have just made has been offered by R. H. Dotterer *(Beginners' Logic,* p. 324*)* in the following statement: "If logic may be trusted to vouch for the correctness of the proof

of infallibility, it can also be trusted to pass judgment upon specific doctrines." This contention, however, cannot be sustained with reference to any sort of authority. We never accept a witness save for the purpose of discovering truth in a particular field of research. In questioning the attributes of an authority we ask whether he is competent to speak of the matter under investigation. He is or he is not, but he cannot be both competent and incompetent at the same time. Once we establish an authority we should be cutting the ground from under our feet if we then questioned the truth of his announcements. The moment tests are applied to testimony the question of the competency of the witness is reopened and the work of proving authority has to be done all over again. "To pass judgment upon specific doctrines" of religion would be an illogical procedure for one who had already submitted to the authority of a church on rational grounds. It is perfectly legitimate, of course, to review these grounds again and again, but when the evidence for authority is finally judged to be unassailable the teachings of authority may not be subjected to criticism.

QUESTIONS

1. Why is it said that every judgment carries in itself a claim to be regarded as true?
2. Define Objective and Subjective Certitude.
3. What in general is Evidence?
4. Discuss the meaning and application of *immediate* and *mediate* evidence.
5. Distinguish intrinsic from extrinsic evidence.
6. Give the ordinary distinction between knowledge and belief.
7. What is Metaphysical certitude?

8. When is the relation of a predicate to its subject seen to be necessary?

9. Give examples of truths that elicit metaphysical certitude (a) by immediate and (b) by mediate evidence.

10. What is Physical certitude?

11. On what sort of evidence is physical certitude based?

12. Show that physical certitude looking towards the future rests upon the principle of uniformity.

13. Is physical certitude altogether unconditioned?

14. With what restriction have we a right to make predictions regarding physical events?

15. Define Moral certitude.

16. Give a reason for saying that there are degrees of certitude.

17. What is the source of our certitude with regard to facts we have not directly observed?

18. What is infallibility?

19. Is human authority ever infallible? If so, on what conditions?

20. In what does the moral certitude arrived at through induction differ from the physical certitude acquired in the same way?

21. State some inductive laws concerning which we have moral certitude.

22. Show that we have a right to make predictions based on such laws.

23. What is meant by saying that the events predicted by moral and physical laws are contingently necessary?

24. Give a reason for saying that highly probable opinions elicit moral certitude.

25. What is the sole ground upon which we can base certitude about facts we have not observed?

26. What particular evidence must be adduced in support of authority that claims to be Divine?

27. Why would miracles have no significance unless there were supernatural revelation?

28. Give a reason for saying that miracles are new creations.

29. Should miracles be more difficult to accept than the facts of the natural order?

30. Show that supernatural truth elicits the highest degree of certitude.

31. Prove that once authority is ascertained to be Divine we have no right to pass judgment upon the specific doctrines it reveals.

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CHAPTER XXX

OPINION AND PROBABILITY

TERMS which are frequently used in contrast with one another come to be regarded as forming a group in which the definition of one serves to throw light on the interpretation of all the rest. The words *certitude, evidence, opinion, probability, doubt,* and *suspicion* constitute a group of this kind. We are familiar with the import of certitude and evidence and before considering opinion and probability we may note briefly the meaning of doubt and suspicion.

DOUBT is a state of mind in which, for fear of falling into error, we refuse to make any judgment whatever concerning the truth of contradictory propositions. The mental attitude called doubt, then, implies a total suspension of judgment. Unwillingness to affirm or deny a predicate of a subject may arise from the lack of a fair reason for doing either or from the existence of good reasons for doing both. In the one case the doubt is called negative, in the other positive. A typical instance of a doubtful proposition is the tossing of a coin; there is no more and no less reason for saying that heads will show than for saying the opposite.

SUSPICION is something of an advance upon doubt; it is not an actual judgment but rather an inclination to judge based on a slight approval of the motives

("suspicious circumstances") supporting one of a pair of contradictories.

OPINION. Certitude, doubt, and suspicion indicate a manner of regarding judgment. Opinion, on the contrary, is itself a judgment—a judgment that does not amount to a law. Under special circumstances opinion, as we have seen (p. 357), is accompanied by moral certitude, but generally it is associated with a prudent fear that its contradictory may be true. It is in this general reference that we shall employ the term hereafter. Opinion should not be understood to contain a rather full amount of truth as if, although a minor part of it were untenable, the major part were certain. Only complex judgments with clearly separable members can be given such twofold, not to say multiple, interpretation. A simple judgment either squares or does not square with reality and is consequently either wholly false or wholly true. Reality is there and is one, apart from any opinion about it. Moreover, the fear of error with which an opinion is held forbids a sweeping denial of the opposite; the most discreet opinion may be false and the most indiscreet opinion may be true.

PROBABILITY. Acceptable propositions which are not self-evident must have a sufficient reason outside themselves; accordingly they are always in the nature of inferences or inductions. It is notorious, of course, that men's judgments are strongly influenced by subjective factors which do not deserve the name of "reasons"—by likes and dislikes, for example, by vague "beliefs," habits of conduct, pronounced prejudices. With opinions that are largely swayed by these personal biases Logic can plainly have nothing to do. The assent of the mind in opinion should

be grounded on motives supported by evidence. Hence inasmuch as opinion properly so called rests upon argument it is to some extent provable or probable. Probability then is *the estimated value of an opinion.* More explicitly, it is *an expression of the weight of the evidence.*

Now in the case of opinion the evidence is never complete. If the total cause of an event were known the mind would be in possession of truth. Only opinion is possible, however, while any of the contributing influences remains unknown. Furthermore an approach to truth would be out of the question unless a knowledge of some important features of the total cause were available. From these considerations it is clear that probability does not lie in the event but in the mind. Given the necessary antecedents the event is inevitable: what makes for uncertainty is our ignorance of just how these antecedents may combine in a particular instance. Consequently, to ascribe a happening to "chance" is merely a confession of ignorance. Jevons emphasizes this point in the following passage: "There is really no such thing as chance, regarded as producing and governing events. The word chance signifies *falling* and the notion of falling is continually used as a simile to express uncertainty, because we can seldom predict how a die, a coin, or a leaf will fall, or when a bullet will hit the mark. But everyone sees, after a little reflection, that it is in our knowledge the deficiency lies, not in the certainty of nature's laws. There is no doubt in the lightning as to the point it shall strike; in the greatest storm there is nothing capricious; not a grain of sand lies upon the beach, but an infinite knowledge would account for its lying

there; and the course of every falling leaf is guided by the principles of mechanics which rule the motions of the heavenly bodies."[1]

There are degrees of probability; in other words, the motive for holding an opinion may be supported by evidence of greater or less strength. Notwithstanding this fact the region of probability is sharply set off from that of certitude on the one hand and of doubt on the other. We are certain of a judgment when we assent to it without a prudent fear of error; we are doubtful about it when we dare give no assent at all; and we count it probable when we assent to it indeed, but with a prudent fear that its contradictory may be true.

SCOPE OF PROBABILITY. When we fall short, but not too far short, of reaching truth we are within the limits of probability. Truth is the aim of every inquiry we undertake, and only because we cannot overcome all the difficulties of knowing are we content with opinion. The search that ends with probability might have ended with certitude had the evidence been stronger. Accordingly no new methods are involved in arriving at probable judgments and no particular sort of subject matter is dealt with. We have only to recall the manner in which true judgments are formed in order to understand the origin of those that are merely probable. Thus probability may issue from the following sources: (a) interpretations of sense experience, as when in the growing darkness we are not certain that a friend has passed though we are "pretty sure" it was he on account of the size and the general bearing of the man; (b) deduction from premises that are either

[1] *The Principles of Science,* 2d ed., p. 198.

separately or in combination merely probable; (c) induction rendered uncertain through inadequate observation, unverified hypothesis, and the use of enumeration and analogy; (d) human authority which, though recognized as fallible, is nevertheless well supported by argument; (e) speculation about past and future events based on the calculation of chances.

Most of our probable judgments, and indeed the most important of them, originate in the first four of these sources. The fifth source is simply a particular case of the second, a deduction from certain mathematical principles and observed phenomena. Hence the mere fact that the calculation of probability is usually given special treatment in texts on Logic should not lead to an overestimation of its value. It is impossible to lend mathematical expression to the weight of evidence except under conditions which by their very nature are of comparatively infrequent occurrence.

CALCULATION OF PROBABILITY. If the difference between certitude, ignorance, doubt, and probability were to be represented numerically, 1 would stand for certitude, 0 for ignorance, 1/2 for doubt and the fractions between 1/2 and 1 for probability. The reasons for adopting this particular scale are manifest: the oneness and completeness of truth are suggested by unity; the simple absence of knowledge is well symbolized by zero; doubt, or suspension of judgment, is rightly conceived to hold the middle place between ignorance and certitude; and probability in its various degrees is fairly brought out by fractions greater than 1/2 and less than 1. Mathematicians do not limit probability as we have here done to fractions greater than 1/2; but the ordinary

logical meaning of probability is lost when it is applied to fractions less than 1/2. Hence in spite of mathematical usage a low probability may be thought of as equivalent to improbability.

Two conditions must be fulfilled before we can undertake a calculation of probability: first, we should know that an event can occur in only one of a definite number of exclusive ways, though we have no means of saying in which way it will occur; and second, we should be certain that in general the same influences are at work to produce the phenomena in question. If the *first* of these conditions be not met there is nothing whatever upon which to base an estimation of the chances. Suppose, for instance, an urn were filled with white and black balls, what is the probability of drawing a white? The problem as stated cannot be solved. In case there were only two black balls the probability of drawing a white would be very great but we could attach no definite numeral to it. We must therefore know all the mutually exclusive ways in which a thing may happen. If the *second* condition cannot be met we should be leaving the element of chance out of consideration. Our ignorance pertains chiefly to the manner in which antecedents combine; that there must be antecedents we are sure, otherwise nothing could happen, and that these antecedents are practically the same we must assume in order to regard the events as forming one class made up of a definite number of groups. Knowledge destroys this assumption and renders calculation misleading. It is plain, for instance, that a series of throws from two dice one of which was loaded could not enter into the same body of calculations. The antecedents are so utterly different as to prevent us

from gathering the individual happenings into a single whole to which we can apply common knowledge.

RULES FOR COMPUTING PROBABILITY. Mathematical probability is the ratio of the number of favorable cases to the total number of equally possible cases. When probability is expressed by "the odds," the chances "for" plus the chances "against" an event equal the whole number of events; for example, if the odds are 8 to 5 in favor of an occurrence there are thirteen possibilities to be considered. The method of finding the ratio depends upon whether the event is simple or compound.

The probability of a simple event is represented by a fraction whose numerator and denominator are respectively the number of favorable chances and the total number of chances. Thus since there are 52 cards in an ordinary playing deck and four of them are queens the chance of drawing a queen is 4/52 or 1/13. Again, if the letters *p, t, a,* are set down casually in a row what is the probability that they will form an ordinary word? There are six possible arrangements, three of which yield a significant monosyllable, pat, tap, apt. Hence the probability that one of these words will appear when the letters are placed haphazardly one beside the other is 3/6 or 1/2. In the first example the odds against drawing a queen are 12 to 1; in the second example the odds are even.

A compound event is one which may be analyzed into two or more simple events which are either (A) independent or (B) interdependent.

A. *When the components, simultaneous or successive, are independent the probability of the compound event is found by multiplying the fractions express-*

ing the probabilities of the single items. The chance of throwing heads with a coin three times running is 1/2 x 1/2 x 1/2 = 1/8. What is the probability of getting two sixes at one throw of a pair of dice? The fraction representing the separate probabilities is 1/6; consequently the probability of the compound event is 1/6 multiplied by itself, that is, 1/36.

B. *When in the case of two (or more) simple events the occurrence of the first changes the probability of the second (and the occurrence of the second changes the probability of the third,* etc.) *the probability of the compound event is the result of multiplying the probability of the first by the probability of the second as influenced by the first (and this product by the probability of the third as influenced by the second,* etc.*).* What is the probability of drawing two blanks in succession, without replacing the first, from a hat which contains three blanks and a marked paper? Of course the problem could not be solved unless the first paper drawn were a blank. The chance of drawing a blank first is 3/4; but when it is drawn the hat contains only two blanks and the marked paper, so the chance of securing a blank on the second drawing is 2/3. Hence the probability of the compound event is 3/4 x 2/3, = 1/2.

QUESTIONS

1. What is doubt?
2. Define negative and positive doubt.
3. What is Suspicion?
4. Define Opinion as the term is employed in this chapter.
5. What is Probability?
6. Is probability objective or subjective?
7. Describe the limits of certitude, doubt, and probability.
8. From what five sources may probable judgments arise?

9. How may we represent mathematically the difference between certainty, doubt, and probability?

10. What two conditions must be fulfilled before we can undertake a calculation of probability?

11. State a problem in which the first of these conditions does not appear.

12. Give a case from which the second condition is absent.

13. Define mathematical probability.

14. How is probability expressed by the "odds"?

15. How is the probability of a simple event represented?

16. Give the rule for computing the probability of a compound event whose components are independent.

17. Give the rule for computing the probability of a compound event whose components modify one another.

18. What is the chance of drawing a king from a deck of playing cards?

19. What is the chance of drawing a king three times in succession, supposing the deck to be complete before each draw?

20. What is the chance of drawing a king three times in succession, provided the kings are not replaced after the first two draws?

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CHAPTER XXXI

OBSERVATION

PERHAPS it is not too much to say that observation is the chief factor in scientific investigation. It constitutes the beginning, it supports the middle and it determines the end of every inductive inquiry. Without it a problem cannot arise, a hypothesis cannot be formed, an inference cannot be confirmed. Its scope, therefore, should be well understood by anyone who engages in a study of natural phenomena.

THE SCOPE OF OBSERVATION. The derivation of the word observation (from *ob,* before, and *servare,* to keep) throws light upon its meaning. Keeping an object before the mind signifies a good deal more than merely letting it make impressions on the senses. In fact the conscious elements that result directly from stimulation are simply the foundation of a complicated structure—the object as presented with its universalized features—in the building of which thinking plays the most important part. The act of examining one's own mental processes is called introspection; but, apart from its being a looking inward instead of a looking outward, introspection does not differ from observation. As commonly employed, then, the term observation denotes a persistent study of external things; it includes all that is meant by elaborated sense perception. Now we have seen that

in concentrated sense perception the intellect is always busy identifying the universal character of the qualities an object possesses. A door, for instance, is perceived as a *door,* as *heavy,* as *white,* as *wooden.* An animal has the same sensations as a human being, yet it does not perceive in the same complete way—it does not universalize as it goes along. In observation the intellect is more active than the senses; for the senses merely furnish the raw material for analysis, recognition, classification, interpretation of relations. The mind gathers all its powers for an act of observation and spends them with energy upon the object. What we have hitherto learned about a thing, or about things that resemble it, is reinstated as we observe and thus forms a point of departure for the acquisition of new knowledge. It is a familiar truth that we take out of experience little more than we bring to it. Consequently whatever we have accumulated through imagination, conception, judgment, reasoning, is but a preparation for the next act of observation.

PURPOSE IN OBSERVATION. When observation is anything more than casual it is conditioned chiefly by purpose; and in a general way purpose may be said to grow out of a need of the moment. We do not study things unless we are urged by a desire to gain some knowledge that circumstances demand we should possess. We observe in order to meet a situation. At times the situation has a practical aspect; an object threatens us and we watch it for the purpose of protecting ourselves, or it pleases us and we dwell upon it for the sake of greater satisfaction. But observation may also be undertaken for theoretical reasons; it is then called scientific, and its pur-

poses are thought of as originating in a desire to know more about an object which has already, and perhaps repeatedly, engaged our attention. The need of the moment in such case depends upon how far our study of the object has progressed; hence a present purpose is determined by what previous observation has accomplished for us. Ordinarily the particular direction which a purpose takes may be indicated by questions, that is, in accordance with our aim we may ask: What kind of thing is this?, What can it do?, What is its origin?, Why does it exist? Questions of this sort, since they plainly imply a search after causes, really institute the problem in a formal way.

EXPECTATION. The presence of purpose in observation involves the influence of expectation, and expectation may act as either a help or a hindrance. In general we see what we are looking for; consequently it is important to look for the right thing. We perceive what we think is probable, that is to say, what we are led to expect. Naturally, then, the character of our sense experience will depend upon whether our expectation is reasonable or not. If expectation is the result of feeling instead of sound thinking it will tend to disturb rather than promote observation. An investigator who permits himself to be dominated by his liking for a particular theory or his fancy for a certain point of view puts himself in danger of overlooking some facts and misinterpreting others. Even when a scientist has done his best to free his mind of prejudice he often realizes the limitation of his powers under the influence of expectation. Nothing is more commendable in a student than zeal, but obviously his zeal should be tempered by caution.

FUNCTIONS OF OBSERVATION. Inasmuch as the

scientist must be in constant touch with facts at every point of an inquiry, it may be said that observation is never finished. The secret of success in the study of nature is unremitting contact with reality. Things perceived through the senses seem to clamor for recognition and do not cease to stimulate the mind until they are completely understood. But although observation is indispensable at any period during a scientific investigation there are three moments in which it plays the most important part, and corresponding to the needs of these moments it displays three functions which may be described as (A) analyzing experience to ascertain the fact (cause or effect) to be explained, (B) further study of the nature of the cause or effect in order to limit the number of hypotheses, and (C) verification of a particular hypothesis.

A. To a great extent the phenomena of sense perception are presented in tangled masses which we call concrete wholes. Of course in so far as they are taken in as wholes at all they must exhibit certain obvious relations of parts, but the more hidden relations of these to one another and to the whole are often difficult to bring out. For instance, in seeking a causal relation we are usually confronted with a cluster of antecedents and a cluster of consequents. Among the antecedents we know there lies the cause of an effect which can be found among the consequents, and to establish a necessary relation between these two terms is in general our problem. Evidently, however, we must isolate one term of the connection before we can hope to find the other. It is the function of observation to do this. For example, an autopsy might show that the internal condition of a body is due to the action of an unknown drug. Thus

by means of observation the first step in the analysis of a concrete exeperience would be accomplished, and the bodily condition would receive rather special definition by being identified as the effect not of brute force or natural causes but of poison.

B. It is something to have discovered that a given phenomenon is the cause or the effect to be studied. Moreover the discovery itself is fruitful in suggesting hypotheses. But the trouble usually is that too many hypotheses are suggested; there are so many possible explanations that the task of dealing with them all by eliminating one after another would be hopeless. It becomes necessary, then, to find a way of reducing the suppositions down to the fewest number that are, under the circumstances, plausible. And here again recourse must be had to observation. We have to go back to the cause or the effect and study its nature with greater care in order to render more remote the probability of certain suggested explanations. Thus, reverting to the effect provisionally defined in the last sentence of the preceding paragraph, we should have to observe more closely the kind of changes that were wrought upon the various tissues and organs before we should be able to say that some poisons could and some could not have produced the result. Further observation of the fact to be explained is therefore a valuable means of reducing the number of possible explanations and enables us to proceed with our induction more directly and more securely.

C. One of the necessary steps in the inductive process is the formation of one or more deductions which amount to predictions of what would occur if the tentative law were operative. Unless these predictions are fulfilled in experince the law of course

will not stand; hence it is observation alone which will enable us to verify our deductions.

CULTIVATION OF OBSERVATION. An accomplished observer must be equipped with good sense organs. One can hardly imagine a color-blind painter or a musician afflicted with tone-deafness. It is, however, a question whether the sense organs like the muscles can be developed through exercise. In vision, in active touch, and to a slight degree in taste, movement is a necessary condition for the use of the organ and in these senses training of appropriate muscles, at least up to a certain point, adds something to the power of perception. For example, ability to estimate the distance and actual dimensions of an object even if its retinal image varies in size is entirely a matter of practice. But the retina, the tactile corpuscles, and the taste buds with which a person is endowed by nature are—apart from modifications due to advancing age or declining health—about the same throughout life. For the most part, then, the manner of receiving sense impressions cannot be improved; consequently the cultivation of observation depends chiefly upon the development of memory, imagination and reasoning.

Earnest thinking makes the keen observer. Keeping a subject on the mind begets motives for looking at it from all sides. An eager student will not stop short of complete mastery over the material he is engaged upon, and his zeal will inevitably provoke a multitude of questions which can be answered only by constant reference to reality. This frequent demand for accurate sense perception is bound to produce a trained observer. But the acquisition of knowledge is not merely an incentive to observation, it is

also a preparation for it. The more we know about an object the better we realize how little of it we thoroughly understand; yet as we progress in learning, the field of the unknown becomes more definitely restricted. What we have already ascertained narrows the limits of our quest and helps us to select points for further observation. Such selection is in itself the most important factor in perception. Knowing what to look for constitutes the difference between aimless and purposeful observation; it directs our attention to the one thing we are seeking and clears the mind, so to speak, for receiving proper impressions.

It should be noted that since men rarely devote themselves with enthusiasm to more than two or three lines of thought, a trained observer in one field is but indifferently equipped for observation in other fields. There is consequently no assurance that an increase of ease and accuracy in the perception of a particular class of things will make for a general improvement of the perceptive faculties. A man's habits of thought tend to confine while they intensify his powers of observation. The poet observes in order to express beauty in language, the painter in order to portray beauty in color and outline, the scientist in order to establish the causal relations of phenomena; and although they might all possess equally good sense organs their powers of observation outside their chosen sphere of activity may be notably deficient.

AIDS OF OBSERVATION

Even when the scientist brings to his work normal sense organs, a facile memory, a fertile imagination, a trained intellect, and a determination to know, he

may still encounter serious objective difficulties. By reason of the limited capacity of the sense organs perception is impossible if stimuli are hidden in a tangled mass, if they are too weak or too intense, too small or too large, too slow or too fast. Conditions such as these can be improved either (A) by the use of instruments without interfering with the natural course of phenomena, or (B) by experiment, that is, an intentional change brought to bear upon the rise and progress of a process under consideration. Neither of these means is a method in itself; both are subordinate to observation and are valuable only in so far as they render it more accurate.

A. MECHANICAL DEVICES for varying the intensity, size, and apparent motion of stimuli will extend the range of observation by indirectly increasing the capacity of sense organs. Thus the use of lenses will so alter the direction of light rays as to produce an enlarged or reduced optical image, and the tube of a stethoscope will so concentrate sound waves as to make heart-beats audible. Sometimes an object or its setting has to be considerably modified before it can be perceived to the best advantage; accordingly we may notice a botanist picking a flower apart in order to reveal its structure, or a geologist cutting down a good portion of a hill in order to study rock formations, or an anatomist removing muscular and adipose tissue in order to expose the parts of an organ. These operations in spite of the labor they may entail are not properly called experiments. The fact is that in some fields of investigation experiments cannot be made, and yet within these very fields observation aided by microscopes, telescopes, spectroscopes, gauges, meters, standards of weight and measurement, and a

great variety of other instruments, has been a fruitful source of many far-reaching inductions.

B. EXPERIMENT is not a substitute for observation; it is an attempt to deal separately with forces that usually work together, and since it is a deliberate interference with the course of external processes it is always under the control of perception. We may say then that the functions of experiment in so far as it is an aid to induction are the same as the three functions of observation described in a preceding paragraph. In accordance with the general trend of scientific investigation experiment, starting from the certainty that phenomena are grouped into small systems the parts of which exhibit causal relations, proceeds to lay bare the composition of such systems, to get rid of any accidental features, and to pare the complex down to its simplest elements. Although there may be haphazard experiments in the sense in which there are casual observations it is the rule that intentional interference with the course of nature is never undertaken except under the guidance of a hypothesis. An experiment, therefore, is always a practical answer to a question that indicates some special purpose of observation—*What will happen if one of the antecedents is removed?, Will a particular consequent vary when one of the antecedents is increased or diminished?, What forces must be brought to bear upon a given compound to reduce it to its elements?* From the character of such questions it will be seen that the experimenter is always occupied with changing the antecedents of a system and he works on the principle that *an antecedent which can be eliminated or varied without destroying or varying the effect is not a real cause.*

What we have described as dealing separately with forces that usually work together is the chief end of experiment. When this end is attained the investigator is in a position to employ in new settings the causal relation thus brought down to its simplest terms, that is, he is able to supply new conditions under which it may work. Having learned, for instance, that a current of electricity will magnetize a given length of coiled wire the scientist may so arrange his magnets as to produce rotary motion. Hence experiment is an important factor not only in analyzing experience but also in producing new phenomena, not only in explanation but also in invention.

In a subsequent discussion of scientific methods we shall have occasion to speak of the rules which underlie the analysis of experience whether by observation or experiment. It will be well to note here, however, that the value of either observation or experiment cannot be fully appreciated without a thorough knowledge of the technique which has been built up around both processes in the various sciences. What can be accomplished through experiments is best ascertained by making a series of them.

QUESTIONS

1. What is meant by Observation?
2. Explain the part that the intellect plays in observation.
3. Discuss the function of purpose in observation.
4. How may expectation hinder observation?
5. What, from the point of view of induction, are the three functions of observation?
6. Show how observation establishes one term of a necessary connection.
7. How does observation help to reduce the number of possible hypotheses?

8. Upon what does the cultivation of observation mainly depend?
9. In what special ways does thinking aid observation?
10. How does the use of instruments facilitate observation?
11. Define Experiment.
12. Show that an experiment is generally a practical answer to a definite question.
13. On what principle does an experimenter work?

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CHAPTER XXXII

ANALOGY

THE end of thought is to put order into experience, to classify, to place like with like, and to keep the unlike apart. And the means to this end is comparison. All thinking, then, implies an attempt to see radical sameness in objects that are somewhat different, or a radical difference in objects that seem much the same. Successful attempts of this sort find expression in valid syllogisms, true propositions, and adequate terms. There are, however, attempts which fall short of complete success and among these is Analogy. Consequently, analogy as a method of reaching out towards the truth does not differ from other attempts to classify except in one important respect—it does not lead us to certainty.

The ordinary analogical way in which the mind acquires new knowledge was pointed out by Shelley in his song "To the Skylark" when, at a loss to realize all that the "blithe Spirit" meant to him, he exclaimed,

> "What thou art we know not;
> What is most like thee?"

Every baffled seeker after truth must ask a similar question. Back of the question there is the conviction that the properties and relations of things are causally connected with their nature. Hence we can

say not only that if two things have the same nature they will exhibit the same essential features but also that the presence in two things of the same essential features arises from the same nature; and likewise, different natures explain different essential features while the latter involve the former. What is to be done, however, when sameness or radical difference of nature or of features cannot be asserted? An obvious expedient would be to fall back upon the closest possible approximation to sameness or radical difference, namely, resemblance or dissimilarity. But since anything like extreme dissimilarity of unessential qualities can lead to no positive results, the only means of advancing in thought is to rely upon similarity. This method of procedure is called Analogy, a word which means *ratio, proportion,* or more generally *likeness.*

DEFINITIONS. Accordingly inference by analogy may be defined as *the attribution (or denial) of a consequent to one relation because this relation resembles another which takes (or does not take) such consequent; or the attribution (or denial) of a characteristic to one thing because this thing has several features in common with another which possesses (or does not possess) the characteristic.* From these definitions it is clear that analogy rests on a comparison of either a pair of relations or the qualities of two things. It should be noted, however, that qualities and relations taken account of in this process do not enter into the essential determination, namely the definition, of the objects compared.

PROXIMATE PRINCIPLES. Like all attempts to reach new truth from the data of experience analogy is governed by the principle of causality, that is, by

the conviction that the presence of the same attributes points to their causal connection. From this conviction it is only a short and apparently a safe step to some such proximate principles as the following:

What is affirmed or denied of a thing may be affirmed or denied of any similar thing.
Like causes produce like effects.
Like natures are endowed with like qualities.
Like structures have like patterns.
Like antecedents take like consequents.
Like products have like purposes.

THE TWO TYPES OF ANALOGICAL ARGUMENT

Depending on whether the act of comparison is directed to a pair of relations or to the qualities of things, analogical inference will be cast in either of two forms, the first of which (A) may be called the Analogy of Relations, the second (B) the Analogy of Qualities.

A. ANALOGY OF RELATIONS. This type of thinking suggests the mathematical form in which a proportion is laid down. Schematically it may be set forth as follows:

A is related to B as C is to D
From the relation of A to B y follows
$\therefore$ From the relation of C to D y follows.

We may fill out the scheme by means of a familiar illustration: the relation of a captain to his ship is like that of a governor to the state; on account of the captain's position he is obliged to lay the ship's course; therefore it devolves upon a governor to guide the destiny of the state. Of course resemblance of

relations may yield a negative conclusion also, for if a given consequent does not follow from one relation it is not likely to follow from the other. Thus, the attitude of a writer towards his readers resembles that of an orator towards his hearers; hence if the orator should not talk over the heads of his audience, the writer should not be unmindful of his reader's limitations. The Scriptural admonition, "Go and do likewise," that is, follow a specific example, involves an analogy of relations, for the counsel is given on the assumption that a person is related to a certain situation in practically the same way as was someone else who handled it admirably.

B. ANALOGY OF QUALITIES. The form of the Analogy of Qualities may be represented schematically as follows:

A resembles B in one or more respects
But besides what is common, A possesses (or does not possess) y
B possesses (or does not possess) y.

We can hardly find a better example of this sort of analogy than the argument astronomers offer for the presence of life on Mars. They contend that Mars resembles the earth in being a planet composed of material that has taken the surface shape of seas and continents; in having an equatorial inclination which together with movement around the sun gives rise to seasons; in rotating on its axis so as to condition the change of day into night; in being a moderate distance from the sun—not so far that the cold is extreme nor so near that the heat is excessive; but since all these points of similarity are favorable to the maintenance of life and since the earth supports life,

there are probably various kinds of living things on Mars.

ANALOGY AND INCOMPLETE ENUMERATION. In "*An Introduction to Logic*" (2d ed., p. 54), Mr. Joseph makes a distinction between analogy and incomplete enumeration which throws considerable light on the nature of both. He writes: "In [enumeration], because a number of instances of a kind x exhibit the attribute y, we infer that all x are y; in [analogy], because two particulars a and b agree in certain respects x, we infer that y, which is exhibited by a will be exhibited by b also." Thus, because most of the books on a shelf treat of history we conclude that all of them do (enumeration); or because two men look alike and one is of Irish blood we conclude that the other comes from the same stock (analogy). In view of the foregoing distinction incomplete enumerations may be described as dealing with extension—universalizing a particular term; and analogy as dealing with intension—enlarging the meaning of one of the analogues. But it is plain to see that on account of the inverse ratio between intension and extension the two processes merge into each other, for when we infer that objects of which we have no direct experience (as books on a shelf) belong to a specific class we add to them the meaning of the class, and when we infer that an object of which we do not possess the full meaning (as a person who looks like another) is entitled to a certain attribute we increase the extension of the object with which it is compared.

THE FORCE OF ANALOGY. Analogy does not give us certitude. Accordingly in contrast with deduction which proceeds from the general to the par-

ticular and with induction which proceeds from the particular to the general, analogy advances from the particular to the particular—that is, it enables us to say that what is true of one thing is true of similar things, but does not permit us to say that these things constitute a class (or nature) of which the predicate is an essential attribute. In the case of the management of a ship and the government of a nation, certain things that follow from the captain's control over his crew follow from the governor's control over the citizens, and yet we are unwilling to place the terms of the relations (captain and governor, ship and state) in identical categories. In spite of such unwillingness, however, a suggested identification of the terms is sometimes hard to evade; when, for instance, Byron says that

"The Assyrians came down like a wolf on the fold,"

he contrives to convey the idea not merely of ferocious destruction but also of the utter lack of distinction between the Assyrians and wolves. Metaphor, indeed, derives its peculiar force from the rhetorician's daring identification of the terms of a relation—an identification which, as we have seen, the logician would be loath to admit.

In so far as Analogy is an approach to the truth it cannot proceed without the aid of a universal. This universal is, as we have already noted, the causal connection which, since it is known to prevail between one relation (or set of qualities) and a certain consequent (or attribute), is thought to prevail between a similar relation (or set of qualities) and the inferred consequent (or attribute). It should be pointed out, too, that the recognition of a causal con-

nection does not always carry us forward from cause to effect but may lead us back from effect to cause. Thus when Shelley sings that the skylark is

> Like a rose embowered
> In its own green leaves,
> By warm winds deflowered,
> Till the scent it gives
> Makes faint with too much sweet these
> heavy-wingèd thieves

he is first aware of the sweetness of the song which he then concludes could come only from the same cause which produces the overpowering sweetness that lies in a full-blown rose.

The fact that advance in thought through analogy leans finally on a recognized causal connection—at least a causal connection which *seems* to serve the purpose of inference—gives a notion of the sort of resemblance that is demanded. Points of resemblance need not be numerous but they must be important, though of course a combination of number and importance is ideal. The test of importance would appear to be this: *the resemblance should be such as to support the causal connection upon which the inference has to rest.* Hence even if the objects compared are widely different, analogy will not be regarded as far-fetched or false provided the inferred attribute is conceded to be a true effect of the feature (or features) common to both analogues. Thus, the relation of an orator to his audience is like that of a whirlwind to a village in its path, because just as the whirlwind is irresistible so the orator "carries everything before him"—both make a "clean sweep;" the common effect, "a clean sweep" reveals the under-

lying universal. On the other hand even if the resemblance between the two terms is very close the analogy may not be able to support an attempted inference: two towns, for instance, may have about the same number of inhabitants most of whom are industrious, intelligent, charitable, fair-minded, and patriotic, yet if one were in the South and the other in the North the fact that negroes are allowed full suffrage in the latter would be no warrant for the conclusion that negroes are permitted to vote in the former. This is so because notwithstanding the remarkable similarity between the two communities there is a vital point of difference: in the Southern town there exists a condition (fear of negro predominance) which works opposite to the effect which might otherwise have been inferred.

USES OF ANALOGY. At the very least a well-grounded analogy is an approximation to truth. Whether such approximation is satisfactory or not depends upon the purpose analogy is meant to serve. There are (A) some circumstances in which the mind does not ask for more than moral certitude, and others (B) in which the demand goes beyond any mere approach to truth however close. In circumstances of the first sort analogy of course meets all the requirements; yet even when nothing short of exact knowledge will satisfy, analogy often makes possible not only the beginning of an inquiry but also its further pursuit.

A. The special ends of poetry and oratory cannot be reached except through analogy. For these types of expression, then, it is altogether an adequate instrument. A reader of poetry does not expect the literal truth. He delights rather in verisimilitude and

counts on being lifted above the world of monotonous facts into a realm where things have fresh and striking relations—where "the morn in russet mantle clad walks o'er the dew," where the red spots in the "gold coat" of a cowslip are "rubies, fairy favors," where the "dull night" may be "startled from his watch-tower in the skies." Thus the definite exaltation of spirit which real poetry induces originates in the happy identification of things that could be brought together only by a master-stroke.

Since the orator aims to sway the will of his hearers he endeavors rather to persuade than to convince. In matters concerning which the truth is difficult to establish men are inclined to follow a course of action from motives based on probability. Generally speaking one may say that what has been successful and admirable in human conduct is worth imitating and what has been unsuccessful and mean should be avoided. Accordingly, aware of the extent to which the emotions color our estimate of the things men do, an orator will appeal to the pride, loyalty, prejudice, love, fear or hatred of his audience by offering them examples (analogies) that may arouse these states of mind and thus lead to imitation or avoidance.

B. From a scientific point of view, the chief use of analogy is to suggest hypotheses. Familiarity with causes which produce certain effects will in an investigation of similar effects narrow the field of research to similar causes. Thus, familiarity with the general way in which weights are lifted led James Watt to suppose that the raising of the kettle-lid was due to the lifting power in the steam. The fact is that probably no important scientific hypothesis has ever been formed without the aid of analogy.

QUESTIONS AND EXERCISES

1. In what respect does analogy resemble other modes of thinking?
2. Quote two lines of Shelley that indicate the circumstance in which analogy is employed.
3. What is the meaning of the term analogy?
4. Define Inference by Analogy.
5. State some of the propositions which may serve as proximate principles of analogy.
6. Give a scheme of the argumentative form in which an Analogy of Relations is presented.
7. Give a scheme for presenting an Analogy of Qualities.
8. Illustrate both forms.
9. Can analogy be based on comparison of objects that are known to have the same nature?
10. Show that offering an example involves analogy.
11. State Joseph's distinction between analogy and incomplete enumeration.
12. Explain the statement that analogy advances from particular to particular.
13. In what does metaphor differ from analogy?
14. What is the universal that controls the process of analogy?
15. What should be the character of a resemblance upon which analogy is based?
16. Is analogy possible even when the objects compared are widely different in nature? Illustrate your answer.
17. Show that analogy is entirely adequate for the expression of poetic thought.
18. For what purpose does the orator employ analogy?
19. Of what use is analogy to the scientist?
20. Point out the analogy in the following lines:
    (1) "With burnt mouth red like a lion's it drank
    The blood of the sun as he slaughter'd sank."
    (2) "The boat is chafing at our long delay."
    (3) "When the hounds of spring are on winter's traces."
    (4) "She holds her little thoughts in sight,
    Though gay they run and leap."

21. What analogies appear in the following propositions?
   (1) War is blood-letting.
   (2) War is the exercise of a nation's organism.
   (3) The advocates of prohibition are fanatics.
   (4) Only socialists would propose such a measure.
   (5) At the time of the murder my client was in a twilight sleep.
   (6) Teddy is a bookworm.

22. Are there question-begging epithets in the foregoing propositions? If so, point them out.

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CHAPTER XXXIII

HYPOTHESIS

INDUCTIVE HYPOTHESIS. As employed with reference to induction, hypothesis signifies the assumption which is made in answer to a definite question raised by observation. Observation as we have seen, gives us one term of a necessary connection; it is the purpose of hypothesis to supply if possible the other term. Accordingly hypothesis is an attempt to complete an explanation which the mind originates whenever it recognizes an object of sense experience as cause or effect. With a universalized known quantity on one side of the question, a supposition is offered to provide the unknown quantity for the other side; thus the ebb and flow of the tide perceived as an effect is balanced by the hypothesis of the attraction of the moon as cause. Not until a fact is isolated and universalized can the method of induction proceed; then assumptions about the corresponding universal are in order. Two universals of this sort, one the product of observation, the other the fruit of imaginative thought, are related in a general proposition, the hypothesis, which if it is verified takes on the character of law. Hence it is proper to regard a hypothesis as a tentative law. Law is sanctioned explanation, hypothesis is explanation with a fair prospect of being sanctioned.

In a broader way of speaking hypothesis is sometimes identified with a supposition that tends to bring into a clearer light facts already known. Thus, to interpret the distance of a remote star in terms of the time required by an express train to reach it, or to reduce a scale of measurement from feet to inches, or to regard the heavenly bodies as points tracing lines through space, would be to make hypotheses in the sense in which we deliberately substitute imaginary for real conditions. Assumptions of this sort have no place in the method of induction, for by means of inductive hypotheses we aim to discover an unknown quantity, the causal complement of an observed fact.

KINDS OF INDUCTIVE HYPOTHESIS. It is customary to distinguish between a Hypothesis of Law and a Hypothesis of Cause. The latter is a more complete explanation than the former, yet both are identical in being provisional expressions of a causal relation. A fact is not thoroughly understood until *all* its causes are revealed. Simply to connect by supposition one phenomenon with another so as to bring out the manner and degree in which they are related is often an achievement of great scientific moment. In fact most of our physical laws have been derived through verification of such suppositions—Newton's theory of gravitation, for instance, was made possible by a Hypothesis of Law. But no matter how exactly a formula may exhibit the fact and details of a necessary connection it leaves something to be desired unless it discloses the nature of the agencies involved and gives us knowledge of the origin of phenomena (efficient cause) as well as the purpose for which they are produced (final cause). Hypotheses of Cause aim to furnish this more thorough explanation. The

marvelous advance which the science of medicine has recently made in the cure of disease has been due to discoveries based on the germ theory. But the germ theory itself was the outcome of a hypothesis of cause. For centuries physicians had nothing to go on except descriptive laws (derived from hypotheses of law) which expressed the necessary connection between the symptoms of certain ailments and the lesions of specific organs—the liver, the spleen, the kidneys, etc., What brought about the lesions was a mystery until the supposition that a great number of micro-organisms working together could break down the healthiest tissue was verified by observation. The resulting germ theory has eliminated much that was purely speculative in pathology and substituted methods whose outstanding feature is exactness. Perhaps no other instance in the history of science illustrates more clearly the advantage of a hypothesis of cause over a hypothesis of law.

When a supposition of law or cause has little prospect of being verified and yet furnishes a convenient formula for arranging and clarifying complex phenomena it is called a Working Hypothesis. Its value is practical rather than theoretical either because it lacks sufficient evidence or because the data it deals with are so intangible as to render verification of deductions impossible. Franklin's assumption that electricity is a fluid affords a good example of a working hypothesis.

REQUIREMENTS OF A HYPOTHESIS. In order that a hypothesis be considered something more than a working proposition it should possess a fair degree of probability, that is to say, it should be supported by sound objective evidence. Such evidence however

rests primarily upon the way in which the fact to be explained is related to kindred facts and to fundamental principles. In general therefore a hypothesis should meet the following requirements:

1. It should harmonize with the laws of thought and of nature. An assumption, for instance, which would imply that a cause is not a positive influence but only a temporal antecedent, or that chance is a governing factor in the universe, must be rejected from the outset. Similarly a supposition which involves the postulate that consciousness is attached to every atom of matter would have to be discarded because it is at variance with scientific teaching concerning the nature of inorganic substances.

2. The hypothesis itself, and indeed any proposition which may be legitimately inferred from it, should not contradict established facts. This requirement gives us to understand that even if a hypothesis is consistently grounded on the laws of thought and nature it cannot be entertained if it runs counter to things that have actually happened.

3. Since a hypothesis is meant to lead up to a law and thus attain a theoretical as well as a practical value, it should not be so abstract as to render verification impossible. A good hypothesis does not generally remain a hypothesis very long, and unless a supposition can be brought out upon the field of observation to receive a thorough test it will never rise above the level of conjecture.

THE INVENTION OF HYPOTHESES. It would be as difficult to indicate how scientific hypotheses arise as to point out the sources of poetic "inspiration." The powers that are at work in the one case are at work in the other—sense perception, a crowded mem-

ory, a vitalized imagination, penetrative thought, and a will to achieve. All the character of a man as well as his total intellectual equipment is needed to account for individual success in any field of endeavor; yet for the sake of convenience it may reasonably be said that the triumphs of science and the arts are mainly due to one factor, namely, training. Constant dealing with a subject, persistent thinking about it, perhaps one might add, a tender regard for it, will light the way to its complete comprehension. We have already noted that the power of observation increases with the growth of understanding. It is also true that the ability to form hypotheses depends quite as much on understanding as it does upon the data of experience. A scientist who saturates himself with his subject by untiring devotion to it will gather strength to cope with new problems as they arise. Hypotheses will be suggested to him as if by inspiration but in reality as the result of heroic industry.

Notwithstanding the difficulty of formulating specific rules for constructing tentative laws it is possible to designate the principal ways in which hypotheses are suggested. These are three in number: (1) Conversion of General Propositions, (2) Enumerative Induction, (3) Analogy.

1. CONVERSION OF GENERAL PROPOSITIONS. As a result of growing experience the mind comes into possession of a great many universal judgments. Objects we have perceived in a haphazard way are little by little arranged into groups, and this order of classification is brought about by means of observing that a common attribute is predicable of many individuals. Thus we attain such propositions as "All crows are black," "All triangles are three-sided," "All living

things act from within." Now the subjects of these various propositions disclose—though often in a confused manner—the causes (reasons) of the predicates; for in the nature of crows lies the explanation of their blackness, in the nature of triangles the explanation of their three-sidedness, and in the nature of living things the explanation of their power of acting from within. But a causal relation is never completely revealed until its reciprocal character stands out. Since a plurality of causes is inadmissible, that is, since only one kind of cause can originate a given effect, we should be able to say indifferently either A always produces B or B is produced by nothing except A. Accordingly not content with superficial classification, when we observe that a group of objects possess a certain attribute we are naturally curious to discover whether this attribute ever appears in connection with any other group; or, what amounts to the same thing, when we reflect upon a categorical proposition of the ordinary A type we are moved to inquire whether the relation of subject and predicate is reciprocal, that is, whether the terms may be simply converted; and when we reflect upon a hypothetical proposition we are prone to ask whether the antecedent is not the sole condition of the consequent. For example, the statement "All living things act from within," suggests the simple converse "Everything that acts from within has life" or "If a thing acts from within it has life." From these considerations it is clear that most of our general judgments present material for speculation because we have merely to convert them simply in order to obtain plausible hypotheses.

2. ENUMERATIVE INDUCTION. Enumerative induction whether perfect or imperfect has no theo-

retical value save to suggest causal relations. Even when counting is complete all that can be announced is a summarization to the effect that a given attribute attaches to every individual of a class. No reason can be offered until a hypothesis about the nature of the various subjects is formulated, and this hypothesis must survive the ordinary tests before anything like a true universal or a scientific law may be announced. If only a few instances of subject-attribute association were observed a hypothesis that the attribute belongs to the nature of the subject might nevertheless be suggested, for any antecedent may possibly be the veritable cause of its consequent. As however the number of instances in which a connection has been noted considerably increases it becomes less and less probable that a case may be found in which the connection does not appear; and a growing probability of this sort affords sufficient evidence for a hypothesis.

3. ANALOGY. In discussing the special laws of association psychologists are accustomed to point out that whereas contiguity accounts well enough for the more or less fortuitous reproductions of ideas, most of the suggestions that give our thought a logical trend arise from similarity. Accordingly analogy is the most fruitful source of hypotheses. Things that are alike suggest the same nature and consequently the same attributes. Indeed when we observe a close resemblance between two objects or relations we can hardly help thinking that a feature which belongs to one will on investigation be found to characterize the other also. A striking illustration of the way in which analogy suggests hypotheses is contained in the

following passage from *The Principles of Science*, by Jevons (p. 530):

> The phenomena of double refraction had been long known, and when engaged in Paris in 1808 in investigating the character of light thus polarized, Maulus, chanced to look through a double refracting prism at the light of the setting sun, reflected from the windows of the Luxembourg Palace. In turning the prism round, he was surprised to find that the ordinary image disappeared at two opposite positions of the prism. He remarked that the reflected light behaved like light which had been polarized by passing through another prism. He was induced to test the character of light reflected under other circumstances, and it was eventually proved that polarization is invariably connected with reflection.

VERIFICATION OF HYPOTHESES. The process of verification consists, as we have seen, in making deductions from the hypothesis and then observing whether they are confirmed by facts. If observation and experiment do not square with the conclusions drawn from a supposition the inquiry is automatically halted until another hypothesis is framed. If on the other hand the supposition and all its legitimate inferences are borne out by the facts it acquires the force of law.

The framing of a hypothesis, important as it should be considered, is merely a means to an end. Truth is not attained until the probability of a supposition is turned into certainty. The scope of verification depends upon the immediate purpose of the hypothesis. An investigation need not have in view

the discovery of all the causes, and when one cause only is sought for, the object need not be to isolate from a set of combined antecedents the reciprocal cause. For example it may be enough to know that a certain mixed drug cures a particular disease without going to the length of ascertaining whether the specific effect is produced by the several ingredients working together or by a single ingredient which would of itself constitute the reciprocating cause.

It should be noted that we are not in possession of truth unless a hypothesis is proved to be the sole explanation of the phenomena under investigation. Even when the supposition accounts for all or most of the facts it may not give us certainty. Suppose for instance that a modified evolution hypothesis, as advocated by A. R. Wallace and St. George Mivart, amongst others, sufficiently explains the origin of species, the question should not on that account be regarded as altogether closed; for the special creation hypothesis is also capable of interpreting the facts. Perhaps the necessity of insisting on a hypothesis which furnishes a unique explanation of experience is even better illustrated by the fate of the Ptolemaic assumption that the earth is the center of the universe. This idea satisfied the requirements of astronomers during thirteen centuries and was only rejected when more accurate means of observation confirmed the theory of Copernicus.

QUESTIONS

1. Show that the hypothesis of induction is the counterpart of observation.

2. Give an example of a supposition which is not a hypothesis in the strict sense.

3. Distinguish between a Hypothesis of Law and a Hypothesis of Cause.

4. What is meant by a "working" hypothesis?

5. Give the three requirements of a serviceable hypothesis.

6. How does an investigator acquire the ability to form hypotheses?

7. Describe the manner in which general propositions suggest hypotheses.

8. Show how enumerative inductions lead to hypotheses.

9. Discuss analogy as a source of hypotheses.

10. In verifying hypotheses is it always necessary to reject a supposition which does not establish a reciprocal cause?

11. Is a hypothesis verified until it is proved to be the sole explanation of a phenomenon?

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CHAPTER XXXIV

SPECIAL RULES OF INDUCTION

INDUCTIVE METHODS NOT MODERN. Induction is as old as human thought. If this were not so deduction would have played an insignificant part in the development of knowledge, for the ultimate grounds of all mediate inference are major premises, only a few of which are axiomatic. It would be idle to contend that the major premises of the ancients were merely enumerative universals incapable of supporting valid argumentation. True generalizations possessing the full force of law must have been numerous enough as soon as men began to understand the significance of the causal relation. Civilization is the product of no particular age. There were wise kings before Solomon, learned physicians before Galen, profound philosophers before Socrates; and there were mechanical, architectural and artistic wonders long before historians popularized the famous seven. Furthermore induction is simply a specific case of conception; both processes are of the same nature and serve pretty much the same purpose. The chief difference between them is that conception expresses a uniform association of subject and common attributes without further determination, whereas induction exhibits a similar uniform association from a causal point of view. But the practice of forming concepts or

class ideas certainly reaches back into prehistoric times and it is incredible that classification should have been consistently pursued without regularly calling forth the generalizations which induction implies.

No doubt, then, men have always known how to form inductions, yet they could hardly have done the work intelligently without also being aware of the fundamental principles involved. In order to explain a phenomenon they must have understood that nothing could be its cause or effect which was absent when it occurred or which was present when it did not occur. This simple rule, which after all is only one step removed from a statement of the law of causality, has been followed by every inductive thinker from the beginning of time and is the foundation of all attempts to indicate in detail the steps by which we rise from the particular data of sense experience to universal laws.

MILL'S METHODS. The most notable of these attempts was made by John Stuart Mill, and the rules he laid down in *A System of Logic*, Bk. III., chap. 8, are now generally known as "Mill's Methods." Five "canons" were formulated, but three of these are merely variants of the first two. This significant fact Mill himself noted in the following words:

> The simplest and most obvious modes of singling out from among the circumstances which precede or follow a phenomenon those with which it is really connected by an invariable law, are two in number. One is, by comparing together different instances in which the phenomenon occurs. The other is by comparing instances in which the phenomenon does oc-

cur, with instances in other respects similar in which it does not. These two methods may be respectively denominated the Method of Agreement, and the Method of Difference.

Too much importance should not be attached to the canons from a theoretical point of view; for on the one hand the statements of the two cardinal methods are open to criticism, and on the other, even after receiving the most liberal interpretation they do not seem to strike deep enough into the roots of the inductive process.[1] However, we may properly regard the methods as setting forth certain necessary features of scientific investigation.

I. THE METHOD OF AGREEMENT

CANON. "If two or more instances of the phenomenon under investigation have only one circumstance in common, the circumstance in which alone all the instances agree is the cause (or effect) of the given phenomenon."

This canon it will be seen is based upon the first of the two simple rules which were described above as being but a short step removed from the principle of causality, namely, nothing can be the cause or effect of a phenomenon which is absent when it occurs. An inquiry which employs this method looks for sameness in the midst of differences; for the canon demands that there be two or more unlike instances in which the phenomenon occurs and that besides the phenomenon there be only one circumstance common to all the instances. Suppose we are seeking the cause of a phenomenon, we should examine different sets of circumstances in which the effect appears with

[1] Cf. Welton, *Manual of Logic*, Vol. II, pp. 146–159.

a view of finding something else that is identical in them—the probable cause. By means of a simple arrangment of symbols in which the capital letters denote antecedents and the small letters consequents we may easily formulate the conditions of this and all other cases of Agreement, thus:

ABC *abc*
FGA *fga*
EAH *eah*

A glance at the features of the different instances will suffice to show that *B, C, F, G, E, H* can be eliminated as possible causes of *a,* for each of them may be absent when *a* occurs; hence, *A,* the antecedent that is common to the three instances, is probably the cause of the effect *a.*

EXAMPLES. Sir David Brewster's discovery of the cause of iridescence has become the classic illustration of the method of agreement. It is described by Jevons in the following words:

> A person might suppose that the peculiar colours of mother-of-pearl were due to the chemical qualities of the substance. Much trouble might have been spent in following out that notion by comparing the chemical qualities of various iridescent substances. But Brewster accidentally took an impression from a piece of mother-of-pearl in a cement of resin and bees'-wax, and finding the colours repeated upon the surface of the wax, he proceeded to take other impressions in balsam, fusible metal, lead, gum-arabic, isinglass, etc., and always found the iridescent colours the same. He thus proved that the chemical nature of the substance is a

> that the chemical nature of the substance is a matter of indifference, and that the form of the surface is the real condition of such colours.[2]

A modified application of the method of agreement was successful in isolating the cause of the yellow color which appears in the flame of any burning substance. The different materials could of course have nothing to do with producing the phenomenon. Air is an invariable antecedent of flame; yet air has several components, and oxygen or nitrogen or indeed any of these might be the reciprocating cause. Two independent discoveries led to the right conclusion; it was found that sodium chloride would add considerably to the yellowness of a flame and that this substance was always present in the air. With these facts before the mind the inference to sodium chloride as the cause of the yellowness was simple enough.

SCOPE. Agreement is peculiarly adapted to inquiries in which, as in astronomy, observation alone is possible; it is never employed as the sole method in experimental sciences.

The wording of the canon has the merit of being in conflict with the notion of a plurality of causes and a diversity of effects. In requiring that the various "instances of the phenomenon under investigation have only one circumstance in common," Mill plainly adheres to the doctrine of reciprocation—one ultimate cause or effect for every single phenomenon.

By implication the canon tells us to pursue analaysis until we find the reciprocating element; it does not tell us how to analyze nor does it indicate how we shall know when we have reached the goal. An in-

[2] *The Principles of Science*, 2d ed., p. 419.

variable antecedent may be a *conditio sine qua non* as well as a real cause; the formula offers no help in making the distinction. In our second example any component of the air is a circumstance that is always present when the effect, yellow light, appears; but only one, sodium chloride, is the real cause.

We have seen that the first step in induction is an act of observation by which we isolate one term (cause or effect) of a necessary relation, yet this important step is presupposed by the test of the formula.

II. THE METHOD OF DIFFERENCE

CANON. "If an instance in which the phenomenon under investigation occurs, and an instance in which it does not occur, have every circumstance save one in common, that one occurring only in the former; the circumstance in which alone the two instances differ, is the effect, or cause, or an indispensable part of the cause, of the phenomenon."

This canon is based on the simple rule that nothing can be the cause or effect of a phenomenon which is present when it does not occur. In employing the method an investigator seeks a difference in the midst of sameness; for the canon requires that all the features of one instance shall be repeated in the other except the phenomenon and a single circumstance both of which appear together only once. The following symbolization will be seen to fit all cases of Difference:

$$\begin{array}{ll} ABC & abc \\ BC & bc \end{array}$$

The antecedents B and C cannot be the cause of a since they are present when a is absent; accordingly A is probably the real cause.

EXAMPLES. Mill offers the following illustration: "When a man is shot through the heart it is by this method we knew that it was the gun-shot which killed him: for he was in the fullness of life immediately before, all circumstances being the same, except the wound."

If a bell is rung in a jar filled with air the sound is readily heard but if the same bell is rung in a jar from which the air has been removed no sound is audible. The presence of air when sound is transmitted and its absence when transmission does not occur may be regarded as evidence that air is probably the cause of the phenomenon.

SCOPE. With reference to the doctrine of a plurality of causes the method of difference carries the same implication as the method of agreement; namely, there is only one cause for any given effect. Beyond question this view is correct, although, as we have stated, the purpose of a particular investigation may be served by ascertaining a sufficient cause without going on to inquire whether it is a combined cause or a cluster of antecedents among which lies the reciprocating cause. But the point is that in spite of directing our aim towards the sole cause or the sole effect, the method of difference suggests no means of continuing an investigation after an invariable antecedent —which may be simply a condition—has been laid bare. In this connection Welton offers the following criticism of Mill's illustration:

> In the very example which Mill selects of a man shot through the heart, it is evident that there is no inference to cause. There is nothing to justify the assertion that if a man dies, he

has been shot through the heart. The method treated fairly, will not even, by itself, justify the universal proposition that if a man is shot through the heart, he dies. Of course, in such a case, we do not argue "inductively" at all, but deductively from our knowledge of physiology and of firearms. Really to test the method, therefore, we must put ourselves in the position of one who has never seen firearms or wounds inflicted by them. A person in such a position would not be justified in drawing a universal conclusion. The shot has caused the death in this case; but it is due to the fact that it passed through the heart, or to some peculiarity of the man; and if the former, would death always attend such a wound? The method gives no means of answering these questions.[3]

The Method of Difference is faulty in another respect. Granted that the antecedents *B* and *C* are the sole causes of *b* and *c*, will the introduction of *A* compel us to regard it as the sole cause of the new effect, *a*? By no means; for *a* may result from *A* entering into combination with *B* and *C*. If, for instance, a dish is unsavory the addition of salt may contribute to render it palatable; no one would say, however, that the agreeable taste should be referred to the salt alone.

III. JOINT METHOD OF AGREEMENT AND DIFFERENCE

CANON. "If two or more instances in which the phenomenon occurs have only one circumstance in common, while two or more instances in which it

[3] *Op. cit.*, Vol. II, p. 154.

does not occur have nothing in common save the absence of that circumstance; the circumstance in which alone the two sets of instances differ, is the effect, or the cause, or an indispensable part of the cause, of the phenomenon."

This formula may become clearer through the use of symbols. To represent the first condition of the canon we have only to set down again our scheme of the method of agreement, thus:

$$\begin{array}{ll} ABC & abc \\ FGA & fga \\ EAH & eah \end{array}$$

Here we have three instances alike in nothing but the presence of one circumstance and the phenomenon. Evidently the repeated appearance of A and a together suggests a causal relation between them. The other elements of the scheme can be eliminated because they may be absent when the common antecedent and consequent occur. But these other elements are capable of being dealt with separately; hence the second condition, which may be represented as follows:

$$\begin{array}{ll} BH & bh \\ FE & fe \\ GB & gb \end{array}$$

Here we have three instances alike in nothing save the absence of the phenomenon and its accompanying circumstance. This absence would not be significant by itself; it becomes evidence only when compared with the repeated appearance that is a feature of the first condition. Now this comparison of the second condition with the first constitutes a real case of the method of difference. Accordingly the Joint Method is one of agreement in so far as it centers attention

entirely upon the first condition and one of difference in so far as it considers the two conditions taken together.

EXAMPLES. Suppose an alarming increase of first degree murder in certain parts of the country should inspire social students to look for an explanation. Preliminary considerations of the problem might suggest several possible causes; inferior police protection, inadequate teaching in the schools, non-attendance at church, bootlegging, and absence of a death penalty. Investigations covering a number of cities in various States where first degree murder is common yield, let us say, the following data:

First City: inadequate teaching; good attendance at church; no bootlegging; efficient police; no death penalty.
Second City: adequate teaching; good attendance at church; bootlegging; inefficient police; no death penalty.
Third City inadequate teaching; poor attendance at church; no bootlegging; efficient police; no death penalty.

According to the method of agreement the only antecedent appearing in all the instances—the absence of the death penalty—is the probable cause. But in order to strengthen this probability the inquiry should be extended to cities in which first degree murder has not been common. The following data might be secured:

Fourth City: adequate teaching; good attendance at church; no bootlegging; inefficient police; the death penalty.
Fifth City: inadequate teaching; good attendance at church; bootlegging; efficient police; the death penalty.
Sixth City: inadequate teaching; poor attendance at church; bootlegging; inefficient police; the death penalty.

All the supposed causes except the absence of a death penalty appear in the last three instances where-

as the phenomenon to be explained—the prevalence of first degree murder—does not occur. This fact taken in conjunction with the previous repeated association of the prevalence of first degree murder with the absence of a death penalty strengthen the supposition that there is a causal relation between them.

Fowler gives an example in which the Joint Method is shown to be well fitted for scientific investigations. The facts are drawn from experiments in Spectrum Analysis. First, when a very thin sheet of light from incandescent hydrogen is passed through a prism, the spectrum thus obtained will exhibit one, two, or more bright lines occupying the same relative position. Second, when very thin sheets of white light coming from various incandescent substances are passed through incandescent hydrogen and then through a prism, the resulting spectra will exhibit lines occupying exactly the same positions as the lines above mentioned. "Hence it is inferred, by the Method of Agreement, that a sheet of light, whether it proceed directly from incandescent hydrogen itself, or be transmitted through it from some other incandescent substance, will invariably produce these lines. But, if we try the same experiments with any other element than incandescent hydrogen, although we may obtain bright or dark lines, we never find these lines occupying the same positions in the spectrum as the lines in question."[4]

SCOPE. We may say in general that the Joint Method is a more thorough procedure than Agreement or Difference applied singly. Accordingly whether the means of taking evidence is confined to observation or extended to experiment the testing of a

[4] *Elements of Inductive Logic*, p. 166.

hypothesis will be more conclusive if the Joint Method is introduced.

All the faults of this method are brought out by our first example. To begin with, the method does not help define the problem and yet everything depends upon an exact knowledge of the phenomenon to be explained. Obviously we are seeking a reason for an excess of first degree murder. But what shall constitute excess? What is meant by saying that a crime is "prevalent" or that it is "common?" Unless this difficulty were solved the method would be of no service whatever.

The example further illustrates the point that whereas the method may lead to the discovery of an invariable antecedent there may be other antecedents —in this case the influence of immoral books, badly censored motion pictures, or vicious journalism—any of which might be a contributing cause or indeed the reciprocating cause, the accompanying circumstances being merely conditions.

IV. METHOD OF RESIDUES

CANON. "Subduct from any phenomenon such part as is known by previous inductions to be the effect of certain antecedents, and the residue of the phenomenon is the effect of the remaining antecedents."

This formula may receive the following symbolic interpretation: Suppose *A B C* are the antecedents and *a b c* the consequents in a system of facts, then if *B* and *C* completely account for *b* and *c*, the cause of *a* is probably *A*.

A briefer symbolization will show that this method is really the method of difference with the process of elimination assumed to have been performed; for by

simply repeating the symbolization of Difference and enclosing the eliminated numbers in parenthesis we may call attention to the causal relation of *A* and *a*, thus:

A B C a b c
(*B C b c*, known as reciprocally related)

EXAMPLES. It sometimes happens that when chemists derive an "element" from different compounds the atomic weight of the resultants exhibits unaccountable variations. Thus Lord Rayleigh noticed that nitrogen produced from the air weighed 2.3102 grams, whereas nitrogen obtained from other sources weighed 2.2990 grams. This discrepancy led to the hypothesis that the nitrogen of the air is combined with another substance; and laborious search for the unknown cause of the residual weight was rewarded by the isolation of argon.

The classic example from Astronomy is the discovery of the planet Neptune. When observers noticed a marked divergence between the actual and the calculated path of Uranus they immediately suspected the disturbing influence of an unknown heavenly body. Adams and Leverrier working independently on a mathematical analysis of the data at hand succeeded in locating almost the exact point from which the residual cause was operating. Their theoretical results were so accurate that the new planet Neptune was observed to be only a few degrees away from the place they predicted it would be.

SCOPE. The examination of residual phenomena has proved one of the most fruitful sources of scientific research; but plainly the real work of discovery could be in no wise promoted by the simple formula

Mill enunciated. The fact is his canon is a rule of deduction rather than induction, for the specific problem of induction really begins where the canon leaves off.

The application of the method to reciprocal causal relations only is emphasized by Mr. Joseph's formulation of the rule: "Nothing is the cause of one phenomenon which is known to be the cause of a different phenomenon."[5]

V. CONCOMITANT VARIATIONS

CANON. "Whatever phenomenon varies in any manner whenever another phenomenon varies in some particular manner, is either a cause or an effect of that phenomenon, or is connected with it through some fact of causation."

Joseph states the rule as follows: "Nothing is the cause of a phenomenon which varies when it is constant, or is constant when it varies, or varies in no proportionate manner with it."[6]

EXAMPLES. As a result of noticing the rise in price when a commodity is scarce and a fall in price when it is more plentiful, prehistoric economists were doubtless able to work out a law of the inverse ratio between supply and demand.

The service Concomitant Variations may render to science is brought out by Jevons in the following passage:

> The most extraordinary case of variations, however, consists in the connection which has of late years been shown to exist between the Aurora Borealis, magnetic storms, and the spots on

[5] *An Introduction to Logic*, 2d ed., p. 440.
[6] *Op. cit.*, p. 440.

the sun. It has only in the last thirty or forty years become known that the magnetic compass is subject at intervals to very slight, but curious, movements; and that, at the same time, there are usually natural currents of electricity produced in telegraph wires, so as to interfere with the transmission of messages. These disturbances are known as magnetic storms, and are often observed to occur when a fine display of Northern or Southern Lights is taking place in some part of the earth. Observation during many years have shown that these storms come to their worst at the end of every eleven years. . . . Close observations of the sun during thirty or forty years have shown that the size and number of the dark spots, which are gigantic storms going on upon the sun's surface, increase and decrease exactly at the same periods of time as the magnetic storms upon the earth's surface. No one can doubt, then, that these strange phenomena are connected together, though the mode of the connection is quite unknown. . . . This is a most remarkable and extensive case of concomitant variations."[7]

SCOPE. Concomitant Variations is really a modification of the method of difference. They are distinct merely in this that whereas in the latter, part of the investigation is carried on by entirely excluding the phenomena and one circumstance, in the former two or more instances exhibit a simple change in the related elements.

In scientific inquiries where so much depends upon

[7] *Lessons in Logic*, pp. 249–251.

accurate, quantitative analysis, concomitant variations, like the method of residues, is constantly employed.

QUESTIONS AND EXERCISES

1. Give a reason for saying that in general the methods of induction are not modern.
2. What simple rule underlies all inductive methods?
3. Give Mill's statement of the Method of Agreement and represent schematically the conditions it sets forth.
4. Upon what simple rule is the canon based?
5. Show that the Method of Agreement is at variance with the doctrine of a Plurality of Causes.
6. Show that the method does not enable us to distinguish between a cause and a *conditio sine qua non.*
7. Give a reason for saying that the first step in induction, namely, the work of observation which isolates the fact to be explained, is presupposed by Mill's formula.
8. State and symbolize the Method of Difference.
9. What simple rule supports the canon?
10. Does this method imply reciprocal causality?
11. Does the method help us to distinguish a real cause from an indispensable condition?
12. If to a set of circumstances in which A is known to be the sole cause of a and B the sole cause of b there is added a new antecedent, C, does Mill's statement of Difference lead us to infer that the new consequent, c, is the sole effect of C?
13. Give Mill's formula for the Joint Method of Agreement and Difference.
14. Symbolize the first condition of this method and show that the representation is identical with that of Agreement.
15. Explain that the method becomes one of Difference only when the two conditions are compared.
16. Criticize the Joint Method with reference to our first example of its application.
17. State and symbolize the Method of Residues.
18. Show that the specific problem of induction really begins where the Method of Residues leaves off.
19. State the canon of Concomitant Variations.
20. Point out the similarity between Difference and Concomitant Variations.

21. Give Joseph's formulae for the methods of Residues and Concomitant Variations.

22. Consider the following problems with special reference (a) to the method involved and (b) to successful establishment of a causal connection:

(1) It was long ago discovered that epidemics of smallpox could be prevented by isolating the earliest cases. What was the idea that prompted this measure? Was it a hypothesis of Law or of Cause? What method was revealed in the verification?

(2) "It has been shown by observation that overdriven cattle, if killed before recovery from their fatigue, become rigid and putrefy in a surprisingly short time. A similar fact has been observed in the case of animals hunted to death, cocks killed during or shortly after a fight, and soldiers slain in battle. The contrary has been remarked when the muscular exercise has not been great or excessive. Hence we may infer that cadaveric rigidity depends upon a more or less unirritable condition of the muscles immediately before death." (Hyslop.)

(3) By what method would you verify the law: "The shorter the pendulum, the faster its swings"?

(4) Observation shows that although the classes and orders of the universe display marked differences they all have a common characteristic: whether they are considered singly or together they bear the stamp of manufactured articles. If they are causes they are also effects, in other words they are secondary causes. Consequently to explain their presence we must assert the existence of a First Cause, an Uncaused Being.

(5) If a coin and a feather are dropped from a height they fall with different velocities; but if they are placed in a glass tube from which the air has been exhausted they fall with equal veloci-

ties. What was the idea that suggested the second experiment? Was it a hypothesis of Law or of Cause?

(6) Beneath a given spot on the surface of the retina the cones are uniform in structure and so far as psychologists can say uniform also in function; yet if a ray of red light falls on the spot consciousness yields a sensation of red and if a ray of blue light falls on the spot consciousness yields blue. Anatomy and physiology, then, since they reveal only a single device—a cone or set of cones uniform in structure and function—do not furnish sufficient data for explaining the great variety of color perceptions. Consequently there is need of supposing the existence of additional devices. One theory, first proposed by Young and afterwards modified by Helmholtz, assumes that there are in the retina three color-perceiving substances: one to receive red stimuli, one to receive green, and one to receive blue. According to the theory when all the substances are active together consciousness yields a sensation of gray. But gray is yielded in the case of persons who are partially color-blind, who cannot, for instance, perceive red. Now how far does this hypothesis seem to meet requirements?

(7) It is said that light as a general rule retards the growth of plants. By what method was this law established?

(8) It has been found that in spite of differences of age, race, color, diet, occupation and habits of living, persons who are bitten by the species of mosquito called anopheles contract malaria. Persons who differ widely in all the respects just mentioned do not contract malaria if they are protected against the bite of anopheles.

(9) The locomotive of a fast express train struck a crowded streetcar and killed half the passengers. It was ascertained that those who survived

wore a certain medal while those who lost their lives did not.

(10) Suppose there is a peculiar odor coming from the direction of the refrigerator. On investigation we find that the butter, meat, fruit, and indeed each of the other articles in the box, has an odor which cannot be identified with what we first perceived. The real cause, then, is outside the refrigerator. Further search reveals the presence of some decayed flowers lying in a nearby corner.

(11) About twenty of the children who went to the picnic caught cold. There were more than a hundred on the grounds, and all ate at a common table and played pretty much the same games. It was discovered, however, that those who caught cold had stolen off to wade in a chilly creek.

(12) In a certain case of right-side paralysis a post-mortem revealed a blood-clot located in the left cerebral hemisphere. What statement could be made with regard to these facts? Would such a statement be the direct product of induction or deduction?

(13) The people you see in this portion of the city are not only poor but shiftless; they are foreigners; all foreigners are poor and shiftless.

(14) It was an old belief that decaying matter such as meat, generated flies. Can you think of the way in which the belief was disproved?

(15) Hold in your fingers the end of a copper wire about six inches long and let a flame play upon the other end; note how quickly the wire becomes too hot to hold. Then hold in your fingers the bottom of a test-tube nearly filled with water and apply the tube, somewhat inclined, to a flame, letting the flame play only upon that part of the glass under which there is water: note that the

water near the surface may boil for a few minutes before a change of temperature at the bottom can be perceived. Similar experiments with non-combustible solids other than copper and with liquids other than water will yield similar differences. What general truth regarding a physical property of solids and liquids is grounded on the evidence furnished by such observations?

(16) If you breathe upon a cold mirror moisture will form on its surface; if the grass is colder than the atmosphere dew will be deposited. Is there a sufficient analogy between the two cases to suggest an identity of causal relations?

(17) After Bastian had proclaimed that life had been observed to generate spontaneously from non-living matter, Pasteur, repeating the experiments which served as a basis for the so-called abiogenetic induction, demonstrated that care had not been taken to prevent micro-organisms from coming into contact with the non-living matter. When observations were made under proper conditions, that is, when to begin with the matter not only contained in itself no vestige of life but was kept safe from the intrusion of micro-organisms, no living things were generated.

(18) Excessive centralization of power in a body politic is a menace to its existence; for over-centralization leads to apoplexy in the head and paralysis in the members.

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CHAPTER XXXV

STATISTICS

EVEN if Mill's methods were all their author claimed them to be they would afford little help to the investigator who lacks a technical knowledge of his subject. In many departments of research the skill of an expert is required merely to discover what problems remain unsolved let alone to suggest means of bringing them to a successful solution. It would of course carry us beyond the confines of Logic to attempt an exposition of the technique that obtains in the special sciences. There is, however, a way of subjecting complicated events to inductive treatment which because of its extensive use in various fields of inquiry deserves at least a brief consideration. This is the Method of Statistics. the nature and value of which we shall now touch upon.

STATISTICS: SCIENTIFIC COUNTING. Statistics is another name for scientific counting, and the Method of Statistics is a device for simplifying complex facts with a view of discovering their relations. From the standpoint of Logic the method of statistics like any sort of empirical procedure is a means not only of isolating phenomena to be explained but also of suggesting and testing hypotheses. In common with the other methods of induction and classification statistics is primarily an instrument of analysis. The concrete

data of sense experience—processes as well as objects at rest—can often be broken up by means of experiment; but often, too, they can be dealt with analytically only through observation of which statistics is simply an aid. Counting itself is of course synthetic, yet, since its purpose is to group certain particulars, it depends upon analysis; addition cannot take place unless the items that are to be numbered and thus gathered into a class exhibit some sort of homogeneity which distinguishes them from the items that are left out of count. Accordingly one of the first steps in the application of statistical methods is the arrangement of material into units belonging to specific classes. But before the material can be treated in this way the terms and bearings of the problem must receive precise interpretation.

UNITS AND CLASSES CONDITIONED BY THE PROBLEM. The object for which statistical information is sought limits the scope of inquiry. It might be interesting to know, for instance, the number of garages in a certain city. Such a problem would be very general, and yet it could hardly be solved without immediately making distinctions. Shall the count include buildings in which other things besides automobiles are stored? Shall it include the temporary warehouses of the builders of automobiles? Shall it include garages in suburbs not yet incorporated? Again, if the investigation were undertaken on behalf of insurance companies, garages built of fire-proof material would be listed separately and those that were close to kitchens or factories would be registered apart from those that were situated in less dangerous locations. This example clearly shows not only that the unit of counting is sometimes difficult to determine

but also that an exact definition of it is of prime importance. A similar accuracy of treatment should extend to the naming and defining of classes. The same object may serve as a unit for different categories. Thus, a duck is "game" for the hunter, "poultry" for the farmer, "water-fowl" for the zoölogist; and according to these various classifications a duck would be counted in with entirely different species of animals—with rabbits for the hunter, with chickens for the farmer, with swans for the zoölogist.

Furthermore both class and unit should be so characterized as to render the results of the investigation definite. If the moral status of two communities were to be compared, endless confusion might follow from the use of the term "moral persons" as a category, for it would be difficult to find the unit that would correspond to any conceivable definition of the title. Accordingly while the title may be retained the unit should be reduced to a lower term, as for example "church-goers." On the ground that "church-goers" are more likely to possess a considerable degree of morality than "non-church-goers," there is some chance that the problem may be solved—at least it would be possible to obtain specific records.

THE COLLECTION OF DATA

Setting forth in precise terms the problem to be solved and determining the units and classes to be counted are only preliminary to the collection of data. This operation is frequently beset with serious difficulties; it is, moreover, a source of many fallacies. Apart from the mere physical and financial obstacles that are often encountered in securing observations at the right time and in the proper locality, there are

the possibilities of error which arise from the making of records. But perhaps the most obvious mistakes originate in the putting and answering of questions. It is not always easy to ask for information in words that are unequivocal, and even when the danger of misunderstanding is practically eliminated, the answer itself may be either a half-truth that conceals the fact, a deliberate falsehood, a thoughtless blunder, or a remark that is meant to be frank but that can be interpreted in more than one way. The questionnaire is a simple and direct way of gathering data, yet it should be employed with the greatest caution.

SAMPLING. When large numbers are to be counted or when the object is to investigate quality rather than quantity the process of sampling becomes necessary. A sample is a specimen which is understood to contain the characteristics of some whole. As a matter of fact, however, a single sample cannot represent the whole unless the latter is perfectly uniform throughout. If, then, there are differences within a given mass under investigation several or indeed many samples have to be supplied before an estimate regarding the nature of the aggregate is possible. Naturally the samples should be taken at random; nevertheless they should include the full range of suspected differences. It would ordinarily be a fault in the use of this method to discard a sample that happens to vary considerably from the rest.

THE PRESENTATION OF DATA

The work of collecting data, were it ever so carefully done, would be rendered useless by inadequate presentation. To simplify the complex is the main object of statistics and to this end the results of an

inquiry should be set forth so that he who runs may read. It is seldom sufficient merely to announce the figures that have been gathered under preliminary class and unit headings; hence with a view of bringing out such relations as inclusion, exclusion, similarity and contrast these headings should be arranged in the form of tables. Since, however, even tables have a tendency to get cluttered up with figures, it is advisable further to digest the accumulated information by means of maps, pictograms and charts.

THE AVERAGE. In general the most successful way of exhibiting the value of extensive figures is to reduce them to an average. Statisticians use the word "average" in more than one sense but, in every case they mean a single substitute for a long array of figures. The arithmetical average—found by dividing a sum-total by the number of its items—is the foundation of all statistical calculations. It is particularly helpful in expressing the number of times an instance occurs within a given space or period. Thus we can easily understand what is implied by the statement that in the United States there are forty deaths a month for every hundred thousand inhabitants or that the daily output of automobiles in Germany is one for every thousand persons. In the following passage Sigwart throws light on the nature of the average by distinguishing it from the concept:

> There is no mystery in the average as such; it is an abbreviation, and it has so much in common with the ordinary logical abstract concept that it neglects all differencess, and we cannot tell from it how far the numbers from which it is obtained, or which it has to represent, may differ from

each other. It is, however, inferior to the general concept in so far as the latter is a statement of what is the same in all particular instances, while the average is merely a fictitious value which may never actually occur in any particular case, and which by itself does not even justify us in expecting that a majority of the particular instances in a region will approximate to it.[1]

INTERPRETATION OF STATISTICS

With regard to their place in the inductive method the three operations we have been considering—the determination of units and classes, the collection of data, the tabulation of results—correspond in function to preliminary observation; that is, they prepare the way for the formation of hypotheses. But they will not serve even this purpose unless they receive an interpretation which is dominated by the motive of discovering causal relations. In fact the gathering of descriptive data would probably not be undertaken unless there were a reasonable expectation that in the long run a necessary connection between phenomena could be revealed. Thus the rainfalls in a given locality together with all their antecedents are still counted in the hope that extended enumeration may furnish a clue to some controlling influence. If there were no such hope, or if, as in the case of eclipses, the causal relation was already discovered, counting would have no interest.

CORRELATION OF SERIES. Successful interpretation of statistics depends largely upon the investigator's familiarity with his subject. An expert's intuition born of skill and hard thinking will do more

[1] *Logic*, Eng. trans., Vol. II, p. 487.

than any number of formal rules to disclose what lies hidden in figures. Everyone, however, ought to be acquainted with the method of explanation called the Correlation of Series. This is really an application of the method of concomitant variations and it assumes that we are justified in announcing a probable causal relationship between two series or classes when their instances or units vary directly or inversely. It should be noted that the variation of instances in two series does not always imply that one set of phenomena is the cause or effect of the other; for instance the price of steel fluctuates in direct ratio to the price of wheat, but these concomitant variations are both said to be the effect of the same cause—a change in general business conditions. Many excellent examples of correlation are to be found in Giffen's *"Statistics,"* among them the following:

> Great light is thrown upon the condition of communities by the indications of the varying number of births, deaths, and marriages. It has been found by experience in past times that the number of deaths increases in times of difficulty and depression which in former ages were very often times of famine. It is still found by experience that the number of marriages and of births rather increases in times of prosperity; consequently there is an indication of the condition of the community, at least of the changes in its condition from time to time, in all these figures of births, deaths, and marriages.[2]

STATISTICAL "LAWS." A good deal of discussion has centered about what have been called the "Laws of Statistics." These are simply generalizations based

[2] p. 49.

on the average and at best they only emphasize the belief that history as well as nature repeats itself. How far this belief can find support in the case of history depends upon what is thought of the contention that there has been a steady progress in civilization. Statistical "laws" serve to bring out the fact that the same kind of event is found to occur about the same number of times in each of a succession of equal periods; thus in a given locality the number of wet and dry days although differing from year to year is the same from decade to decade; in the United States the yearly average of marriages, suicides, murders is a constant quantity; in other countries the average for these events may be lower or higher but they are constant for these countries. Commenting upon the significance of such uniformity Welton says:

> This all points to the fact that social and material conditions remain comparatively unchanged for mankind in general. But it is an error to assume that such a statistical uniformity proves anything beyond its own existence. If it occurs again we are justified in concluding that the same causes have been at work in society as a whole. But with regard to the future we can only judge that the same numbers will be found to hold, if the same general conditions remain. To speak of uniformity as a "law" which must of necessity be fulfilled is to misuse language, for all a "statistical law" can say is, if all conditions remain unchanged for the next period of time, then will all their consequents be realized. But this is mere tautology, for it simply says, If the past be exactly repeated it will be exactly re-

peated. The very question is whether all the conditions—known and unknown—will remain unchanged.[3]

THE VALUE OF STATISTICS. The uniformities of statistics may cease at any time. Their persistence even in the case of physical events cannot be predicted; for the higher law of the uniformity of nature guarantees only that the same cause will always produce the same effect, not that any particular concurrence of phenomena will be repeated again and again. Indeed we know that the energy of the universe is being gradually "dissipated" and that the higher forms of it will grow less and less "available" until they are finally "degraded" into heat. Consequently it is certain that physical phenomena of a complex sort will not remain constant over all future periods. This fact would destroy the value of statistical regularities as "laws," but it would in no way affect either the principle of causality or the belief in the uniformity of nature.

If the statistical regularities that pertain to the realm of physics do not tell us with certainty about the future, surely those that depend upon the conduct of moral agents can give us no warrant to make predictions except on assumptions that lie altogether apart from the regularities themselves. Human nature does not change and the conditions in which men live are from the ethical point of view comparatively constant. The exercise of free will is not motiveless and, since the occasions that elicit human behavior are rather uniform, it is evident that different men should again and again formulate the same reasons for the things

[3] *Op. cit.*, Vol. II, p. 198.

they do. A noticeable uniformity of conduct as a result of free activity is exactly what might be expected.

Statistics, therefore, do not yield laws in the strict sense of the word. Under the most favorable conditions they may attain to enumerative universals which, as we have seen, throw no light whatever on the necessary connection of phenomena. The chief function of statsitics is to enable the investigator to form plausible hypotheses as to causal relations, but these hypotheses have to be verified in the ordinary way before they acquire the force of law.

QUESTIONS

1. What is the Method of Statistics?
2. Show that although counting is a synthetic process it presupposes analysis.
3. Describe by means of an illustration the way in which the selection of classes and units depends upon the statement of a problem.
4. Under what different headings can you place the following objects: a diamond, a piano, an ox, a gasoline tank. wine, fur, mustard?
5. Name some of the obstacles that may be encountered in the collection of data.
6. What is meant by a sample?
7. When and how is samplying employed?
8. What in general is to be said about the presentation of data?
9. To what extent is the mathematical average used in statistics? How is it found?
10. In what does the average resemble the abstract concept? In what do they differ?
11. What motive should dominate the making of statistical records?
12. Show that the Correlation of Series is merely an application of the method of concomitant variations.

13. What facts do statistical laws aim to set forth? Give an example of a statistical law.

14. What assumption must be made before we can base predictions on statistical laws?

15. Show that the uniformities of statistics may cease at any time.

16. Is there any reason for saying that different men, acting freely, will do pretty much the same things again and again?

17. Give a summary of the value of statistics.

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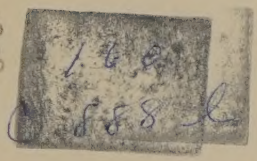

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